DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SYSTEM REQUIREMENTS DOCUMENT

NEXT GENERATION AIR/GROUND COMMUNICATIONS (NEXCOM)

The NEXCOM Integrated Product Team, AND-360

RECORD OF CHANGES

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1.0 INTRODUCTION

This is the System Requirements Document (SRD) for the Next Generation Air/Ground Communications (NEXCOM) System.

1.1 Background

The Mission Need Statement (MNS 137) and the subsequent NEXCOM Investment Analysis Report describe shortfalls in the spectrum capacity of the current Air/Ground (A/G) communications system. Demand for new A/G communication voice frequency assignments, especially for already congested Terminal and surrounding airspace, and for frequencies to support a variety of new A/G communications services in the limited very high frequency (VHF) band is expected to grow four percent annually. This level of growth cannot be accommodated by the current analog system. Other needs called out in the MNS include a reduction in logistical costs for maintaining radios, introduction of new data link capability, a reduction in radio frequency interference (RFI), and improved security against threats such as "phantom controllers."

In response to these needs, the NEXCOM Investment Analysis identified a segmented program for upgrade and replacement of the present air traffic control (ATC) A/G communications string. The NEXCOM Requirements Document (RD) also identified a number of operational and technical constraints, which must be accommodated while satisfying these requirements. Specifically, a fundamental requirement of NEXCOM Segment 1 is to provide additional voice channels with no disruption of the present voice service. Furthermore, NEXCOM is to achieve this increased capacity with minimum disruption of the present VHF A/G communications physical system configuration. Finally, NEXCOM seeks a seamless evolution from the present analog double sideband-amplitude modulation (DSB-AM) A/G system to the new digital communications functional capability.

The Joint Resources Council (JRC) approved Segment 1 of the NEXCOM System in May 1998. NEXCOM Segment 1 would have introduced VHF Digital Link (VDL) Mode 3 digital voice capability to the En Route environment.

In 1999, the NEXCOM acquisition strategy was revised in order to mitigate perceived risks associated with the 1998 JRC approved strategy. The revised strategy delays the introduction of digital voice as first planned to meet ATC requirements, but incorporates risk mitigation and budget affordability. The new strategy focuses on requiring that NEXCOM is fully integrated with the National Airspace System (NAS), that the ground and airborne systems are developed and deployed in a coordinated manner, and that the NEXCOM System initial and follow-on support services progress in an incremental manner. This revised acquisition strategy was approved by the JRC in May 2000.

The revised strategy includes three segments:

a) Segment One includes:
   1) Procurement of multi-mode digital radios in FY01, which is consistent with the 1998 NEXCOM JRC approved Acquisition Strategy Paper (ASP)

2) Building user consensus, buy-in and commitment through working with industry and with both standards and rulemaking bodies to encourage timely development and equipage of VDL Mode 3 avionics.
3) Developing and evaluating the NEXCOM integrated voice and data system to mitigate risk associated with the separate voice and data implementation plan of the original strategy 4.
4) Continuing to reduce spectrum congestion, where possible, via workarounds
5) Producing and deploying digital voice for high and super high En Route sectors

b) Segment Two adds data capability to the high and super high en route sectors.
c) Segment Three extends NEXCOM digital voice and data to other operational environments.

1.2 Purpose

This SRD serves as the focal point for all system requirements affecting the development of the hardware and software necessary to implement the VDL Mode 3 system for integrated voice and data. The NEXCOM System also introduces new requirements on external equipment with which it interfaces. It represents the FAA requirements and system integration are presented through detailed functional and performance allocations to relevant NEXCOM Subsystems. The SRD provides requirements traceability from the RD and other relevant NAS implementation policies, orders, and standards to each detailed subsystem specification.

1.3 Scope

This document describes the NEXCOM System requirements. It establishes:

a) System architecture and the system boundaries and interfaces within those bounds.
b) System technical characteristics including functional and performance requirements.
c) Operating environments.

This document encompasses all NEXCOM segments and includes data requirements. The Ground Network Interface (GNI) will eventually perform subnetwork management for Air Traffic Services (ATS) in the Aeronautical Telecommunications Network (ATN) environment.

This SRD recognizes the avionics element as integral to system operation. However, avionics requirements are discussed only as they affect the ground system design. The scope of the document is focused on the NEXCOM ground system.

Figure 1-1 illustrates the NEXCOM document development process. The figure identifies the NEXCOM RD as the source of the top-level program requirements. In addition to the operational requirements, the RD identifies and references other high level documents and/or activities that must be considered when deriving the major technical constraints placed on the system design.

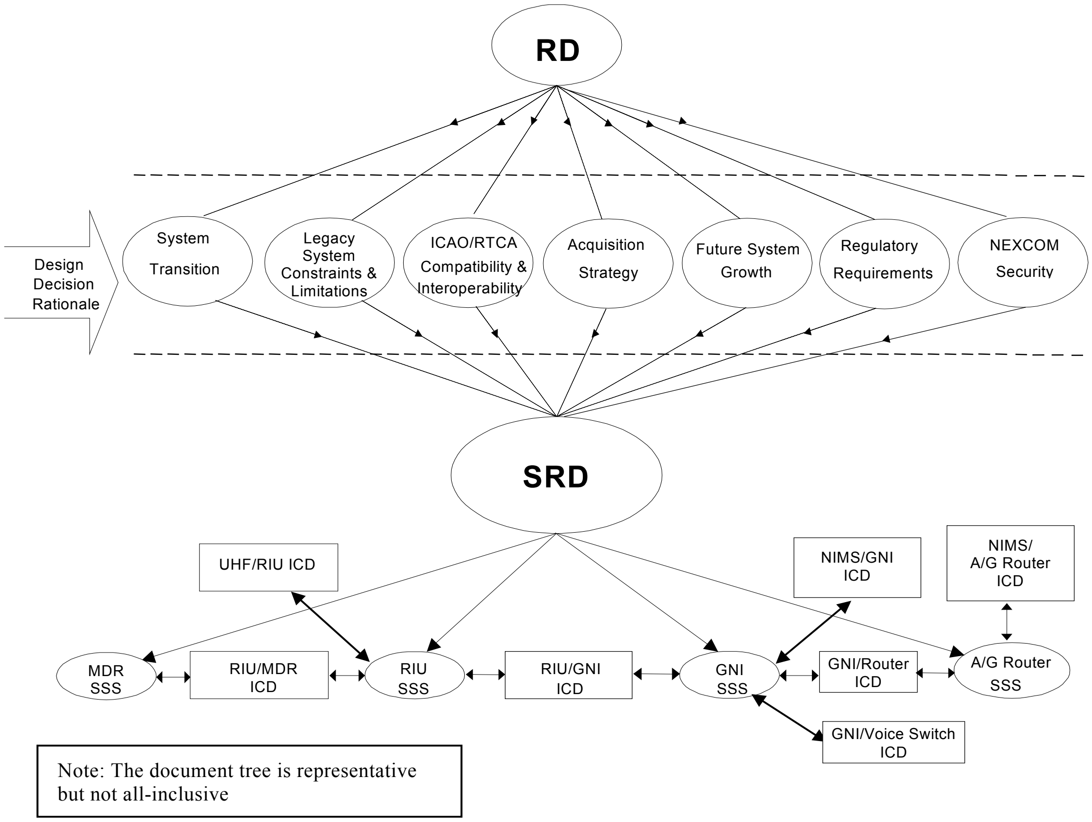


Figure 1-1

NEXCOM Document Development Process

This SRD responds to the RD and defines the functionality and performance requirements of the NEXCOM System and its boundaries, as a result of technical consideration of the major categories noted in the Design Decision Rationale of Figure 1-1. The SRD is the parent document for each subordinate NEXCOM Subsystem Specifications (SSS) for the Multimode Digital Radio (MDR), the Radio Interface Unit (RIU), the Ground Network Interface (GNI), and the Air/Ground Router. It influences Interface Control Documents (ICDs) between NEXCOM Subsystems and ICDs for interfacing NEXCOM Subsystems with other linked systems.

Besides the requirements of the RD, the major areas of architectural influence identified in Figure 1-1 are discussed briefly below.

a) System Transition – The NEXCOM System must operate within the allocated A/G VHF communications spectrum and co-exist with the present analog DSB-AM system. Simulcast of analog and digital communications on separate frequencies within a sector is not envisioned as a nationwide system option; hence, proposed system transition plans require that all users operating in a sector be equipped appropriately. Furthermore, the first implemented segment must leverage the existing telecommunications infrastructure, as applicable, to meet its digital voice requirements. An efficient transition will first allow the benefits of spectrally efficient A/G communications that provide additional new voice channels and then will include data with new voice and data communication and control features. Both a smooth transition plan from the current VHF spectrum usage and an integrated plan for supporting digital telecommunications and attendant interfaces will be required. Such plans require that NEXCOM MDRs be capable of being installed and operated in analog mode until such time as a full cutover of the sector to VDL Mode 3 operation can be made. At cutover, to operate in a digital sector, Mobile Users must be equipped with VDL Mode 3 avionics.

b) Legacy System – The NEXCOM System must interface with existing equipment and operate within existing Remote Communications Facilities (RCF). Also, the equipment must use and be compatible with the current support infrastructure such as power grids, heating, ventilation and air conditioning (HVAC). Additionally, the NEXCOM equipment must satisfy the unique requirements of existing equipment that it replaces. This includes services performed by the Radio Control Equipment (RCE), which will eventually be removed and replaced by NEXCOM equipment.

c) International Civil Aviation Organization (ICAO) compatibility – The NEXCOM System must provide interoperable communications on an international basis. Operational modes within the NEXCOM System must be compliant with relevant ICAO Standards and Recommended Practices (SARPs), be consistent with the appropriate RTCA Minimum Aviation System Performance Standards (MASPS), and be compatible with the corresponding RTCA Minimum Operational Performance Standards (MOPS).

d) Acquisition Strategy – The NEXCOM acquisition is a Non-Developmental Item (NDI) procurement for the MDR and a developmental contract for other components of the NEXCOM System. As part of the NAS sustainment activity, the NEXCOM System must provide new radio capability, in addition to legacy capability, through form and functionally compatible equipment for replacement of the currently fielded radios. The NEXCOM System will be procured in segment steps, which deliver separate benefits in a building block strategy.

e) Future System Growth – The NEXCOM System must be capable of evolving to meet anticipated voice and data demand and provide for integrated digital voice and data link functionality. To do this, existing telecommunications may be upgraded to support these new services.

f) Regulatory Requirements – The NEXCOM System must meet all regulatory requirements that are determined to be appropriate. This determination will be made based on knowledge of regulatory requirements and the evaluation of the SRD as it applies to those requirements. It is anticipated that the NEXCOM Subsystems will be level C equipment under the safety assessment definitions provided by RTCA DO-178B guidance. The application of this guidance is still under review.

g) NEXCOM Security – The NEXCOM system must meet Security Requirements outlined in FAA Order 1370.82. The System must meet certification and authorization requirements in accordance with FAA Guidelines and must introduce no vulnerabilities to the NAS or other systems with which it interfaces.

1.4 Document Organization

Section 1 states the purpose and scope of this specification, its relationship to other program source requirements documents, and the driving influences that must be considered in satisfying those requirements. It also defines terminology that provides the basis for consistent references in developing system level requirements.

Section 2 defines the applicable reference documents cited in this specification.

Section 3 specifies the NEXCOM System functional, performance, and other top-level requirements. This section is formatted so that functional requirements are identified prior to the corresponding performance requirements. Therefore, these requirements are in related subsections (functional requirements identified in Section 3.2 correspond to performance requirements in 3.3 and have similar numbering).

Section 4 defines the verification process for the NEXCOM program.

Section 5 provides applicable notes for this SRD.

Appendix A provides general NAS A/G site configuration information about the current A/G communication systems.

Appendix B identifies NEXCOM System architecture for the functional allocation presented in Section 3.

Appendix C identifies NEXCOM Security objectives.

Appendix D provides traceability matrices that map RD and other source requirements to SRD requirements.

Appendix E provides the Reliability, Maintainability, and Availability (RMA) allocation of the proposed system architecture identified in Section 3.

Appendix F provides a detailed budget for end-to-end audio delay allocations for the NEXCOM System.

1.5 Definitions

A/G Communications System - All equipment and functionality in the ground path from the controller to the antenna, including redundancy, that provide radio communication services.

Air/Ground Router - A NEXCOM System router that is based on ICAO defined routing protocols for the ATN. It is the access point for the NEXCOM System to the NAS ATN network. This Air/Ground Router supports a dynamic routing process that allows the route information possessed by each router to be updated as a result of the movement of the Mobile User.

Authentication – Identification and authorization within the NAS are the processes by which automated mechanisms in the NAS verify the identity claimed between users and devices. Identification and authorization in the NAS also verifies the claimed identity of a user or device which is attempting to access the system. Authentication is performed only in the context of an existing session.

Authorization Management - the initialization, assignment, and modification of access rights (e.g., read, write, execute) to MMC functions with respect to group membership (privilege level) and such constraint as port-of-entry.

Beacon - Beacon is a function of the VDL Mode 3 ground radio uplink Management (M) burst that conveys critical system configuration information and the system timing reference to the Mobile User radios for net initialization and continued net operation.

DLS Frame - VDL Mode 3 datalink service entity protocol unit.

Downlink - Communication from a Mobile User to a ground station.

En route Communications (ECOM) Service - Radio communications between Air Route Traffic Control Centers (ARTCC) and in-flight Mobile Users.

Ground Network Interface (GNI) - ATC control site functions that interface with the voice switch, the Air/Ground Router functions, and the RIU functions to support exchange of voice and data between air traffic controllers and Mobile Users.

Harmful Interference - Interference which endangers the functioning of a radio navigation service or of other safety services or which seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with the Regulations.

Malicious Code and Data – Software or firmware that is intentionally included in a system for an unauthorized purpose; e.g., a Trojan horse.

Mobile User – Any radio frequency user of the NEXCOM System, other than the air traffic controller (e.g., aircraft, handheld radios, and vehicle radios). RTCA DO-224A refers to aircraft, but applies to Mobile Users as well.

Momentary Interruption - Power loss/degradation that does not affect the operation of the system.

Multimode Digital Radio (MDR) - A NEXCOM ground site A/G VHF radio, either a separate VHF transmitter unit or a separate VHF receiver unit, configured to operate in one of three selectable modes, 25 kHz DSB-AM (existing analog voice only), 8.33 kHz DSB-AM (analog voice only), and VDL Mode 3 (digital voice and data on the same frequency in separate time slots).

NEXCOM System - All control site and remote site equipment in the voice/data ground path from the output of the voice switch (or in the future possibly from the output of the controller console automation system) and from the output of the NAS ATN Ground Router to the antenna port of the radio (exclusive of telecommunication or other interfacility transmission media).

NEXCOM Subsystem - An element in the NEXCOM System that provides new functional capability for the NAS.

PCM Voice Message - The message communicated between the RIU function and MDR to pass a portion of uncompressed, digitized audio information encoded using Pulse Code Modulation (PCM).

Power Failure - Power loss/degradation that does effect the operation of the system and causes the system/subsystem to lose any volatile state information.

Radio Control Equipment (RCE) - Existing analog radio control equipment which will be replaced by functionality in GNIs at control sites and in RIUs at A/G radio sites.

Radio Interface Unit (RIU) - A ground radio site function that interfaces with and controls operation of specific MDR units and specific legacy UHF DSB-AM A/G radios, contains vocoders to convert voice signals between analog and digital, interfaces with a time function to provide NEXCOM System timing to MDRs, and interfaces with a GNI at the control site usually through a telecommunications link.

String (also referred to as thread) - A circuit (closed path), providing communication for a User Group through the NEXCOM System.

Strong Authentication – Authentication with two or more factors used in authentication process. Three possible choices are something you know (e.g., password), something you have (e.g., token), or something you are (e.g., fingerprint).

Sustainment - A NEXCOM 25 kHz DSB-AM mode that retains the existing A/G Communication System architecture, while incorporating NEXCOM VHF MDR transmitters and receivers in control and remote A/G VHF radio sites without modifying existing racks, power, or other supporting infrastructure.

Talk Group - A group of ground and/or Mobile Users, which share direct voice connectivity. Talk Group is a subset of User Group. In this SRD UHF stations and the associated VHF stations are treated as separate Talk Groups with the ground station common to both the UHF and VHF Talk Groups. For Dual Control operations the UHF and the associated VHF Talk Groups are commonly called paired Talk Groups.

Thread (also referred to as string) - A circuit (closed path), providing communication for a User Group through the NEXCOM System.

Uplink - Communication from a ground station to a Mobile User.

User Group - A group of ground and/or Mobile Users, which share direct voice and/or data connectivity. In this SRD the UHF stations and the associated VHF stations are treated as separate User Groups. In this SRD there is no UHF data connectivity defined.

Voice Burst Message - The message communicated between the GNI and RIU, or RIU and MDR to pass the compressed, digitized audio information associated with one to six vocoder frame(s).

1.6 Programmatic Assumptions

The NEXCOM architecture is based on the following assumptions:

a) The RCE and BUEC improvement programs will be completed prior to the fielding of the NEXCOM System.
b) The FAA ground infrastructure is required to support only 25 kHz DSB-AM and VDL Mode 3 operation throughout the transition from DSB-AM to VDL Mode 3. However, for risk mitigation purposes, 8.33 kHz DSB-AM is included as an MDR radio function.
c) VHF radio sustainment is part of NEXCOM. NEXCOM will use the MDR 25 kHz DSB-AM capability for current infrastructure sustainment.
d) Ultra High Frequency (UHF) A/G communications will remain analog and will continue to require support from NEXCOM. UHF radio replenishment is not part of the NEXCOM program.
e) NEXCOM will continue to support 121.5 MHz emergency communication using DSB-AM modulation.
f) No new radio sites are required for the NEXCOM program.
g) VDL Mode 2 is not part of the NEXCOM System. It is part of the Aeronautical Data Link (ADL) System and is interfaced through the NAS Routers to the service provider.
h) The NEXCOM System will be classified as a critical service as defined in NAS SR-1000, Section 3.8.1, for voice and data and as stated in the NEXCOM RD Section 3.2.1.1.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this SRD to the extent specified herein. Secondary references, or those documents referenced by documents contained in this section, also form a part of this SRD to the extent specified by applicable sections of the documents referenced directly in this section.

2.1 Government Documents

2.1.1 FAA Specifications

Doc No.	Document Title	Version / Date[1]	Sections[2]
FAA-C-1217F	Electrical Work, Interior	February 26, 1996	
FAA-E-2885	Down Scoped Radio Control Equipment (DSRCE)	December 15, 1993	
FAA-E-2911	System Level Specification, NAS Infrastructure Management System (NIMS) Managed Subsystems		
FAA-G-2100G	Electrical Equipment, General Requirements,	October 22, 2001	
FAA-P-2883	Purchase Description, VHF/UHF Air/Ground Communications Receivers	April 14, 1994	
FAA-P-2884	Purchase Description, VHF/UHF Air/Ground Communications Transmitters	April 14, 1994	
NAS-SR-1000	NAS System Requirements Specification	November 27, 1991	
NAS-SS-1000	NAS System Specification, Volume I	September, 1990	3.2.x

2.1.2 FAA Orders

Doc No.	Document Title	Version / Date	Sections
FAA Order 1370.82[3]	Information Systems Security Program	June 9, 2000	
FAA Order 3900.19B	Occupational Safety and Health Program	April 29, 1999	
FAA Order 6000.30C[4]	National Airspace System Maintenance Policy	January 25, 2001	
FAA Order 6000.36A	Communications Diversity	November 14, 1995	
FAA Order 6040.15C Chg 3	Analysis of Facility/Service Performance	May 27, 1997	par 702
FAA Order 6630.4A	En Route Communications Installation Standards Handbook	July 9, 1999 Rev A and May 16, 1983	

[1] Dates and versions are the latest that could be found.
[2] Sections referenced are used at a minimum. Others may apply.
[3] Supercedes FAA Order 1600.66 and 1600.54B.
[4] Supercedes FAA Order 6000.30B *Policy for Maintenance of the NAS through the Year 2000.*

Doc No.	Document Title	Version / Date	Sections
FAA Order 6950.2D	Electrical Power Policy Implementation NAS Facilities	October 1, 1998	
FAA Order 6000.47	Maintenance of Two-Point Private Lines	December 30, 1996	
FAA Order 6000.22A	Maintenance of Digital transmission Standards	June 29, 1999 including CHG 4	

2.1.3 Other FAA Documents

Doc No.	Document Title	Version / Date	Sections
NEXCOM RD	Requirements Document for Next Generation Air/Ground Communications System (NEXCOM), Segment 1	May 4, 1998	
CPDLC RD	Requirements Document for the Controller-Pilot Data Link Communications		
MNS 137	Next Generation A/G Communications System	March 6, 1995	
DOT SS-98-01	DOT Policy for Seismic Safety in Existing Facilities	January 1998	
NAS-IC-42014000	VSCS to the Existing Radio Control Equipment ICD for the Voice Switching and Control System (VSCS)	October 10, 1997	
NAS-IC-64024201	VSCS to Backup Emergency Communications ICD for the Voice Switching and Control System, (VSCS)	August 8, 1997	
FAA ISSA	FAA Information Systems Security Architecture (ISSA), version 1.1	September 30, 2000	

2.1.4 Other Government Documents

Doc No.	Document Title	Version / Date	Sections
Executive Order 12088	Federal Compliance with Pollution Control Standards, as amended by EO 12580	October 13, 1978	
Executive Order 13101	Greening the Government through Waste Prevention, Recycling, and Federal Acquisition	September 14, 1998	
Executive Order 13123[5]	Greening the Government through Efficient Energy Management	June 3, 1999	
Executive Order 12873	Federal Acquisition, Recycling, and Waste Prevention	October 20, 1993	
Executive Order 12699	DOT Implementation of Energy Order 12699		
Executive Order 12902	Energy Efficiency and Conservation at Federal Facilities		
Doc No.	Document Title	Version / Date	Sections
FEMA-74	Reducing the Risk of Non-Structural Earthquake	September 1994	

[5] Supercedes EO 12902.

	Damage, Third Edition		
40 CFR var. Parts	Environmental Protection Agency Regulations	July 1, 2000	Part 261
49 CFR 41	Seismic Safety	July 14, 1993	
29 CFR, 1910	Occupational Safety And Health Standards	July 1, 1999	
29 CFR, 1926	Safety and Health Regulations for Construction	Various	
47 CFR Part 68[6]	Connection of Terminal Equipment to the Telephone Network		
(47 CFR) Part 2	Frequency Allocations And Radio Treaty Matters; General Rules And Regulations	October 1998	
(47 CFR) Part 87	Aviation Services	October 1998	
NTIA	Manual of Regulations and Procedures for Federal Radio Frequency Management	January 2000 including May/September 2000 Revisions	(Chapters II, V, VII, X, and Annex B)

2.2 Non-Government Documents

2.2.1 ICAO Standards

Doc No.	Document Title	Version / Date	Sections
ICAO Annex 10	International Standards and Recommended Practices (SARPs) - Volume II (ATN SARPs)		
ICAO Doc 9705 ICAO Annex 10	Manual on the Technical Provisions for the Aeronautical Telecommunications Network (ATN) International Standards and Recommended Practices (SARPs) - Volume III	Edition 3 / November 2001 Amendment 75 / November 2001	Part I, Chapter 6
		Amendment 72+	Part II, Chapter 2
ICAO Annex 10	International Standards and Recommended Practices (SARPs) - Volume V	Amendment 75	Chapter 4
ICAO Doc X ICAO Doc X	Manual on VHF Digital Link (VDL) Mode 3 Technical Specifications Manual on the Implementation of the Very High Frequency (VHF) Digital Link Mode 3 (VDL Mode 3)	November 2001 November 2001	

[6] Supercedes FAA Order 1600.66 and 1600.54B.

2.2.2 Industry Standards

Doc No.	Document Title	Version / Date	Sections
RTCA DO-178B	Software Considerations in Airborne Systems and Equipment Certification	December 1, 1992	
RTCA DO-224A with Change 1	Signal-in-Space Minimum Aviation System Performance Standards (MASPS) for Advanced VHF Digital Data Communications Including Compatibility with Digital Voice Techniques	October 12, 2001	2.0, 3.3, 3.4, 3.5, 3.10, 3.11
NFPA Standard 70	National Electrical Code		6.2
ANSI/IEEE 1100-1992	IEEE Recommended Practice for Powering and Grounding Electronic Equipment	1999	
ANSI/IEEE C62.31-1987	Gas-Tube Surge-Protection Devices	1987	
ANSI/IEEE C62.36-1994	Surge protectors used in Low-Voltage Data Communications, and Signaling Circuits	1994	
ANSI/IEEE C62-41-1991	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits	1991	
ANSI/IEEE 519-1992	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems	1992	
EN-300-676	EMC and Radio Matters (ERM); Hand Held Mobile and Fixed Transmitters, Receivers, and Mobile Service using Amplitude Modulation; Technical Characteristics and Methods for Measurement.		
Telcordia (formerly known as Bellcore) TR-NWT-000335	Voice Grade Special Access Service Transmission Parameter Limits and interface combinations	May 1993	
Telcordia (formerly known as Bellcore) GR-499-CORE	Transport Systems Generic Requirements (TSGR) Common Requirements	December 1998	
Electronic Industries Association (EIA)-310-E	Cabinets, Racks, Panels, and Associated Equipment	March 17, 1999	

2.3 Order of Precedence

a) When the requirements of this document and referenced applicable documents are in conflict, this document **shall** have precedence over all documents referenced herein.

b) If either two or more referenced applicable documents are in conflict or two or more sections of this document are in conflict, AND-300 **shall** be notified to resolve the conflict.

2.4 Availability of Documents

2.4.1 FAA Documents

Copies of FAA specifications, standards, and publications may be obtained from the NEXCOM Contracting Officer, FAA, 800 Independence Avenue SW, Washington, DC 20591. Requests should clearly identify the desired material by number and state the intended use of the material. FAA-G-2100G may be downloaded from the FAA at http://www.faa.gov/asd/standards/index.htm.

2.4.2 Federal Documents

Copies of federal publications may be obtained from the US Government Printing Office, 710 North Capitol Street, Washington DC, 20401, by calling (202) 512-0132, or through the web site http://bookstore.gpo.gov/.

2.4.3 International Civil Aviation Organization (ICAO) Documents

Copies of ICAO documents may be obtained from the ICAO Library, 999 University Street, Montreal, Quebec H3C 5H7, Canada.

> ***Note:*** *For current working documents that are not final products, inquire at ICAO web site http://www.icao.org.*

2.4.4 RTCA, Inc. Documents

Copies of RTCA, Inc. documents may be obtained from RTCA, Incorporated, 1828 L Street N.W., Suite 805, Washington, DC 20036-4001, by phone (202) 833-9339, or through the web site http://www.rtca.org.

2.4.5 IEEE Documents

Institute of Electrical and Electronics Engineers (IEEE) documents may be ordered from the IEEE Computer Society Press. Ordering information is available over the Internet at http://www.computer.org/cspress/order.htm or by calling (800) 272-6657.

2.4.6 ANSI Documents

American National Standards Institute (ANSI) and International Organization of Standardization (ISO) documents may be obtained from the American National Standards Institute, 11 West 42nd Street, New York, NY, 10036, or through the web site http://www.ansi.org.

2.4.7 Telcordia Documents

Telcordia (formerly Bellcore) documents may be obtained from the web site http://www.telcordia.com.

3.0 REQUIREMENTS

When used in this document, the word “**shall**” refers to an explicit requirement of a system component or the complete system.

3.1 Functional System Description

This section provides an overview and serves as an introduction to the requirements stated in the SRD. For a better understanding of the current system see Appendix A, and for the proposed future system see Appendix B.

NEXCOM will support a voice and data communications capability that meets the emerging needs of the FAA’s A/G communications in areas such as system capacity, reliability, maintainability, availability, and voice and data quality. A simplified representation of the NEXCOM System is shown in Figure 3-1. The system will be capable of operating in the currently allocated Aeronautical Mobile (Route) Services (AM(R)S) spectrum (117.975 to 137 MHz). The NEXCOM System can operate either in DSB-AM or VDL Mode 3; VDL Mode 3 can provide up to four separate time slots in each existing 25-kHz-wide frequency assignment.

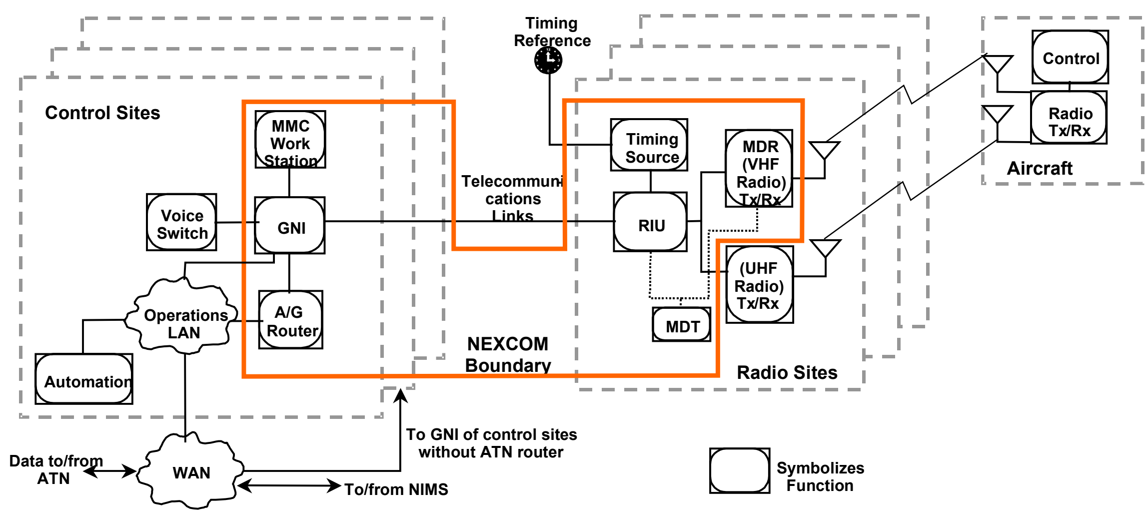


Figure 3-1

NEXCOM System Overview

The NEXCOM System includes both control site and remote site capabilities.

In a control site, NEXCOM connects to a voice switch through a Ground Network Interface (GNI). The GNI also serves as a connection to Air Traffic (AT) data inserted into NEXCOM

through A/G Routers. The ATN data are routed through a Wide Area Network (WAN). At the control site the WAN connects to the site Local Area Network (LAN).
In a remote communications facility (shown as Radio Site in Figure 3-1) NEXCOM will include RIUs, which can control MDR transmitters, MDR receivers, UHF transmitters, and UHF receivers. NEXCOM also includes a timing function, which receives highly accurate clocking and is capable of synchronizing timing at radio sites. A portable Maintenance Data Terminal (MDT) is used for on-site maintenance and parameter adjustment.

The connecting links between GNIs at control facilities and RIUs at radio sites is external to the NEXCOM boundary. In general, the connectivity comprises telecommunications links, usually provided by leased Telecommunication services.

3.1.1 System Functions

The NEXCOM System includes the following functions:
a) Multimode Digital Radio (MDR)
b) Radio Interface Unit (RIU)
c) Ground Network Interface (GNI)
d) A/G Router
e) Timing Source
f) Maintenance, Monitoring and Control Workstation (MMCWS)
g) Maintenance Data Terminal (MDT)

3.1.1.1 MDR Transmitter and MDR Receiver

An MDR is either a VHF radio transmitter or a VHF radio receiver.
a) MDRs are located at radio sites (remote or local).
b) An MDR can operate in ICAO defined analog or digital modes.
c) In digital mode, multiple User Groups can share a common frequency with different time slot assignment.
d) The MDR interfaces to the MDT.

3.1.1.2 RIU

a) RIUs are located at radio sites[7].
b) The RIU controls both Very High Frequency (VHF)[8] MDR units and Ultra High Frequency (UHF)[9] DSB-AM radios.
c) RIUs interface with their GNI via telecommunications links.
d) The RIU transfers NEXCOM MMC data between the radio and the control site.
e) The RIU provides timing for the MDR in VDL Mode 3 operation.
f) The RIU interfaces to the MDT.

3.1.1.3 GNI

a) GNIs are located at the control sites.

[7] In general, an RIU is collocated with its MDR transmitters and receivers. However, separate RIUs may be used to support the separated transmitters and receivers.
[8] In this context VHF means the frequency band 117.975 to 137 MHz.
[9] In this context UHF means the frequency band 225 to 400 MHz.

b) GNI interfaces to voice switches.
c) GNI interfaces to A/G Routers.
d) The GNI integrates voice and data.
e) The GNI transfers NEXCOM MMC data between the radio site and the control site.
f) The GNI provides MMC data to a NIMS interface.
g) The GNI interfaces to the RIU via telecommunications links.
h) GNIs interface with the MMCWS.

3.1.1.4 A/G Router

a) An A/G Router is located at selected control sites.
b) The A/G Router interfaces to the ATN.
c) An A/G Router may provide an interface for more than one GNI.

3.1.1.5 Timing Source

a) A timing source is located at each radio site.
b) The timing source provides highly accurate and stable clocking to collocated RIUs.
c) The timing source is used by each RIU to maintain system timing.

3.1.1.5.1 MMC Workstation

a) An MMCWS is a fixed NEXCOM local workstation.
b) The MMCWS provides MMC capability from a fixed workstation for all NEXCOM components.
c) The MMCWS connects to the GNI.

3.1.1.5.2 MDT

The MDT is a software application that resides in a portable platform that is temporarily connected to the MDR or RIU.
a) The MDR-MDT performs MMC for the MDR.
b) The RIU-MDT performs MMC for the RIU(s) and remote MMC for the MDR and the UHF radio.

3.1.2 System Interfaces

The following subsections describe NEXCOM System interfaces. Figure 3-1 shows the NEXCOM System boundary. There are external interfaces (NEXCOM to systems external to the boundary) and internal interfaces that are inside the NEXCOM System boundary.

3.1.2.1 Internal Interfaces

The NEXCOM System internal interfaces are interfaces between NEXCOM elements. The internal interfaces include the following:
a) MDR Receiver/RIU
b) MDR Transmitter/RIU
c) GNI/RIU
d) A/G Router/GNI
e) GNI/MMC Workstation
f) MDT/RIU

g) MDT/MDR Receiver
h) MDT/MDR Transmitter
i) GNI/GNI
j) RIU(s)/Timing Source

3.1.2.2 External Interfaces

The key NEXCOM external interfaces can be identified from Figure 3-1 as follows:

a) Antennas
b) Timing Reference
c) Voice Switch Communications Equipment (VSCE)
d) Telecommunications links at the radio sites and at the control sites
e) Site LAN (this includes interfaces to the ATN, NIMS, and other control sites through the WAN, as well as an interface to site automation)
f) UHF Radio Receiver
g) UHF Radio Transmitter

3.2 NEXCOM System Functional Requirements

The NEXCOM System functional requirements that support integrated voice and data Air/Ground Communications are described in the following subsections. The corresponding system performance requirements are described in Section 3.3 generally using the same numbering sequence as this section.

3.2.1 Integration Within the NAS

The following subsections provide the requirements for integration of the NEXCOM System into the NAS.

3.2.1.1 Existing Facility

3.2.1.1.1 Site Configurations

a) The NEXCOM System **shall** support the following site configurations:
    1) Single Remote Communications Facility (RCF)
    2) Separated transmitter/receiver sites
    3) Primary RCF with backup site (e.g., BUEC)
    4) Diversity site group (e.g., multiple RCFs for a user group)
    5) Dual control

    ***Note** 1: See Appendix A, Sect. A.3.2.2 for an explanation of Separated Transmitter/Receiver sites. See Section 3.2.3.5 and Appendix A, Sect. A.3.2.2 for an explanation of diversity site group. See Section 3.2.3.6.9 and Appendix A, Sect. A.3.2.1 for an explanation of dual control.*
    ***Note** 2: A local radio installed at a control facility is considered one of the configurations mentioned above.*

3.2.1.1.2 NAS ATS Facility Compatibility

a) The NEXCOM System **shall** operate within existing NAS ATS facilities.

__Note__ 1: The goal is to require no modification to existing infrastructure support (i.e., HVAC, power, grounding, bonding, shielding and lightning protection).
__Note__ 2: This means that the NEXCOM System must not generate harmful interference where installed and operating.

3.2.1.2 Coexistence

3.2.1.2.1 Coexistence with the Present System

a) All NEXCOM modes specified in Section 3.2.2.a. **shall** coexist with the current VHF/UHF DSB-AM system throughout the NAS.

__Note__: This means that the NEXCOM System must not generate harmful interference to Air/Ground Communications.

3.2.1.2.2 Coexistence Among NEXCOM Modes of Operation

a) All NEXCOM modes specified in Section 3.2.2.a. **shall** coexist with all NEXCOM modes throughout the NAS.

3.2.1.2.3 Coexistence with other Existing Systems

a) The NEXCOM System **shall** coexist with any existing FAA systems.

__Note__: The NEXCOM System must not generate harmful interference to other FAA systems (e.g., navigation, landing, and surveillance), and the NEXCOM System must also operate under the existing RFI environments.

3.2.2 Modes of Operation

a) The NEXCOM System **shall** operate in each of the following selectable modes:
   1) VDL Mode 3
   2) 25 kHz DSB-AM
   3) 8.33 kHz DSB-AM

__Note__ 1: The 25kHz DSB-AM mode of operation allows for and supports the transition of the NEXCOM System from analog voice to integrated VDL Mode 3 digital voice and data.
__Note__ 2: This requirement allows for the use of 25 kHz DSB-AM emergency communication channels (121.5 MHz) is a dedicated voice service even when in VDL Mode 3 operation.
__Note__ 3: The 8.33 kHz DSB-AM mode of operation allows for a programmatic fall back and may be removed from this document at a later date.

b) The NEXCOM System **shall** operate a UHF DSB-AM mode simultaneously with VHF modes in each User Group as needed.

c) The NEXCOM System **shall** meet United States regulatory functional requirements specified in (Part 2 and 87) and NTIA (Chapters II, V, VII, X, and ANNEX B).

3.2.2.1 VDL Mode 3 Standardization

a) The NEXCOM System **shall** meet the VDL Mode 3 functional requirements for ground systems specified in RTCA DO-224A.

3.2.2.2 25 kHz DSB-AM Standardization

a) The NEXCOM System **shall** meet the 25 kHz DSB-AM functional requirements specified in FAA-P-2883 and FAA-P-2884.

3.2.2.3 8.33 kHz DSB-AM Standardization

a) The NEXCOM System **shall** meet the 8.33 kHz DSB-AM functional requirements specified in ICAO Annex 10 and ETSI specification EN-300-676.

3.2.2.4 Channel Labeling

a) The NEXCOM System **shall** operate with the ICAO channel labeling for each of the modes identified in Section 3.2.2.a.

   ***Note**: This channel labeling requirement implies additional requirements on other NAS databases such as the voice switches and automation systems.*

3.2.3 User Group Communications

The following subsections provide requirements for User Group communications.

3.2.3.1 Voice Communications Requirements

a) The NEXCOM System **shall** allow all users in a Talk Group to monitor all voice communications within that Talk Group.

   ***Note** 1: This requirement is fulfilled by the proper implementation of the modes of operation specified in Section 3.2.2.*
   ***Note** 2: This requirement does not require the rebroadcast of voice traffic when the system is configured to operate for a single sector/control airspace.*

b) Data communications, including data communications overloading, **shall** not prevent the operation of voice communication.
c) The NEXCOM System **shall** route received audio to the NEXCOM/VSCE interface based on the received audio at the remote site.

   ***Note** 3: If audio is received at the remote site it should be routed to the corresponding audio port at the VSCE. This configuration is only defined when more than one audio output is utilized at the control site.*

3.2.3.1.1 Voice Channels

a) The NEXCOM System **shall** interface with existing VSCE (e.g., VSCS, ETVS, ICSS, RDVS, STVS) via existing interfaces (e.g., Single channel VHF + UHF (V+U) and quad channel VHF/UHF/MAIN/ STANDBY (V/U/M/S)).

3.2.3.1.2 Voice Encoding/Decoding

a) The NEXCOM System/VSCE interface **shall** include:
   1) Analog voice
   2) Digital voice
b) Voice encoding/decoding for VDL Mode 3 **shall** be in accordance with the vocoder algorithm specified in ICAO Annex 10, Vol. III, Part 1, Chapter 6.

3.2.3.1.3 Voice Path

3.2.3.1.3.1 Uplink Path

a) The NEXCOM System **shall** transmit uplink voice out of the radio at the site(s) selected by the controller.

   Note: *The NEXCOM System should not restrict the ability to transmit from multiple sites per sector. However, the VSCS may have a restriction based on its design.*

3.2.3.1.3.2 Downlink Path

a) The NEXCOM System **shall** route all downlink voice output from all selected receivers to the VSCE.

   Note: *The current system delivers all downlink voice outputs to the VSCE.*

3.2.3.1.3.2.1 Local Audio Monitoring

a) The NEXCOM System **shall** present, in an analog format for local monitoring at the remote site, the downlink voice received at the remote site.
b) The NEXCOM System **shall** present, in an analog format for local monitoring at the remote site, the uplink voice received at the remote site.
c) The NEXCOM System **shall** present, in an analog format for local monitoring at the control site, the downlink voice received at the control site.
d) The NEXCOM System **shall** present, in an analog format for local monitoring at the control site the uplink voice received at the control site.

3.2.3.2 Data Communications Requirements

The following requirements are only applicable when the NEXCOM System is operating in the VDL Mode 3 service.

3.2.3.2.1 Data Service

a) The NEXCOM System **shall** provide for a subnetwork for two-way addressed data communications between ground and Mobile User systems.

b) The NEXCOM System **shall** provide for uplink broadcast using the same subnetwork as the two-way addressed service.
c) The NEXCOM System **shall** provide for uplink data broadcasts that do not depend on any information received over two-way addressed services.

Note: This includes providing an uplink data broadcast subnetwork without supporting two-way service.

d) The NEXCOM System **shall** provide Air/Ground routing consistent with ICAO Annex 10 and ICAO Doc 9705 (Edition 3).

3.2.3.2.1.1 ATN Compatibility

a) The NEXCOM System **shall** interoperate with ATN-based Air/Ground Routers and avionics routers as defined in the ICAO Annex 10, and ICAO Doc 9705 (Edition 3).

3.2.3.2.1.2 Make-before-Break Support

a) The NEXCOM System **shall** support Make-before-Break (MbB) capabilities as described in RTCA DO-224A, Section 3.3.3.3.

3.2.3.2.1.3 User Authentication

a) The NEXCOM System **shall** support authentication of user attempts to initialize connections per RTCA DO-224A, Section 3.3.2.3.2.8.
b) The NEXCOM System **shall** deny access to unauthorized parts of the NAS interfacing to the NEXCOM System.

3.2.3.3 Continuous Broadcast

a) The NEXCOM System **shall** provide continuous ground-to-air broadcast within a service volume for the modes identified in Section 3.2.2.

Note: This applies to both voice and data broadcasts.

3.2.3.4 Connectivity

3.2.3.4.1 Entry Into a Talk Group

a) The NEXCOM System **shall** allow any Mobile User, operating in the correct mode, entry into any Talk Group within the Talk Group's service volume.

Note: This is to ensure that the Mobile User can enter a Talk Group regardless of whether or not the Mobile User was instructed to do so by the ground controller. For example, in the case where the Mobile User has lost communication with its own Talk Group, it should still be able to access another Talk Group.

3.2.3.4.2 Automated Transfer of Communication

a) The NEXCOM System **shall** upload channel assignment information to a Mobile User system via the VDL Mode 3 Next Net capability defined in RTCA DO-224A.

Note: This requirement is intended to support Transfer of Communication (TOC) via Next Net messaging.

3.2.3.4.3 Subnetwork Connectivity Reporting

a) The NEXCOM System **shall** report to the A/G Router only those connectivity changes to the subnetwork that affect the A/G Router connectivity decisions.

Note: This requirement is intended to allow masking of the subnetwork for certain connectivity changes in order to prevent excessive Inter-Domain Routing Protocol (IDRP) updates to the system by the router.

3.2.3.5 Ground Station Operations

a) The NEXCOM System **shall** support diversity site group(s) operation (See Appendix A for DSB-AM and Appendix B for VDL Mode 3).
b) When operating in VDL Mode 3, the NEXCOM System **shall** schedule the VDL Mode 3 uplink M-Burst of the ground transmitters to avoid self-interference.

Note 1: One way of avoiding the interference of M-Bursts for the same User Group radiated from different ground sites is to coordinate uplink M-Burst transmissions to allow only one uplink M-Burst per MAC cycle.

c) When operating in VDL Mode 3 and in any User Group, the active transmitter **shall** not cause harmful interference with any other User Group operating on the same frequency.

Note 2: This applies to all Main/Standby and BUEC transmitters.

3.2.3.6 NEXCOM System ATC Operational Signaling and Controls

In this section the NEXCOM System Operational ATC Signaling and Controls functional requirements are specified. These requirements are linked to external systems in that those external systems are responsible for displaying of the information generated by the NEXCOM signals to the controller. NEXCOM is responsible only for making the information available to the interface.

3.2.3.6.1 Push-to-Talk Transmitter keying (PTT/PTT Release)

a) The NEXCOM System voice channel uplink access **shall** be based on PTT assertion.

3.2.3.6.2 PTT/PTT Release Confirmation

a) The NEXCOM System **shall** provide confirmation of PTT/PTT Release on a per Talk Group basis. [RD 3.1.7.1]

***Note** 1: The activation of the Ground Stuck Microphone Correction function, used to disable NEXCOM RF transmissions, releases the PTT signal and will cause the PTT Confirmation to be de-asserted.*

b) The NEXCOM System **shall** be configurable to provide confirmation of PTT/PTT Release based on the reception of the transmitted signal.

***Note** 2: This capability provides a means to monitor whether transmitters are actually radiating when the receiver is close enough to the transmitter to allow the receiver to indicate sufficient RF power is being produced.*

3.2.3.6.3 Preemption of Mobile Users' Voice Transmissions (Controller Override)

a) When operating in VDL Mode 3, the NEXCOM System **shall** provide a selectable function that allows the controller to preempt Mobile Users' voice transmissions on a per Talk Group basis as follows:
   1) Preemption Off (function disabled)
   2) Preemption On (Upon PTT activation preemption occurs)
   3) Momentary Preemption on a single PTT basis (Dynamic function selectable by the controller)

***Note** 1: This pre-emptive access provides a limited capability to cope with various operational issues including the "stuck" microphone condition by allowing authorized ground users to deactivate the transmitter of the offending user.*
***Note** 2: The Voice Preemption function (also referred to as controller override) is activated only when the PTT is asserted.*
***Note** 3: In the momentary preemption mode, preemption is in effect for a single PTT. Controller selects momentary preemption, presses PTT, and preempts Mobile User voice transmissions one time. When PTT is released, preemption reverts to the "Off" state.*

3.2.3.6.4 Preemption Confirmation of Mobile Users' Voice Transmissions

a) The NEXCOM System **shall** generate to the NEXCOM/VSCE interface a Voice Preemption Confirmation signal during the assertion of preemption by the ground station.

3.2.3.6.5 Squelch Break

a) In DSB-AM mode, the NEXCOM System **shall** generate to the NEXCOM/VSCE interface a Squelch Break signal, based on detection of a radio frequency transmission above a configurable threshold.
b) In DSB-AM mode, the NEXCOM System **shall** suppress the audio output unless a radio frequency signal above a preset threshold is detected.
c) In VDL Mode 3, the NEXCOM System **shall** generate to the NEXCOM/VSCE interface a Squelch Break signal, based on detection of a radio frequency transmission for that Talk Group's voice subchannel above a configurable threshold.

***Note**: Squelch Break is intended to indicate the presence of RF energy for each Talk Group on the voice channel. This includes detecting if two aircraft have simultaneously keyed their radios.*

d) In VDL Mode 3, the NEXCOM System **shall** implement the squelch function based on RTCA DO-224A Section 3.3.5.

3.2.3.6.6 Received Audio Muting

***Note**: Mute is infinite attenuation for the requirements below.*

3.2.3.6.6.1 PTT Mute/Attenuation

***Note**: In the requirements below, muting of the received uplink audio is to prevent the controllers from hearing their own ground station transmissions. These requirements are also impacted by Dual Control (Section 3.2.3.6.9 e) and f)).*

a) For VDL Mode 3 operation, the NEXCOM System **shall** be configurable (on a per Talk Group basis) to mute (at the control site asserting PTT) any received uplink voice bursts attempting to provide audio to the VSCE interface.
b) For DSB-AM modes of operation, the NEXCOM System **shall** be configurable (on a per Talk Group basis) to mute (at the control site) received uplink audio (provided to the VSCE interface) during the assertion of PTT.
c) For DSB-AM modes of operation, the NEXCOM System **shall** be configurable (on a per Talk Group basis) to attenuate (at the remote site) received uplink audio during the assertion of PTT.
d) For DSB-AM modes of operation, the NEXCOM System **shall** be configurable (on a per Talk Group basis) to continue to attenuate (at the remote site) received uplink audio from 0 to 600 ms, in 10 ms increments after release of PTT at the remote site.

***Note**: These requirements allow for recording at the control site (voice).*

3.2.3.6.6.2 Commanded Mute/Unmute

a) The NEXCOM System **shall** support mute/unmute of the received audio (at the radio site on a per Talk Group basis) based on the operator input (e.g., VSCE, MMC, etc.).

3.2.3.6.6.3 Commanded Mute/Unmute Confirmation

a) The NEXCOM System **shall** provide confirmation of the received audio muting/unmuting (at the radio site on a per Talk Group basis) to the operator, while mute is asserted (e.g., VSCE, MMC, etc.).

3.2.3.6.7 Ground Radio Resource Selection and Switching

3.2.3.6.7.1 Ground Radio Resource Selection

a) The NEXCOM System **shall** select Ground Radio Resources (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary) for voice operation based on the operator input (e.g., VSCE, MMCWS, and/or MDT).
b) The NEXCOM System **shall** support independent Ground Radio Resource Selection for voice operation by different Talk Groups.
c) The NEXCOM System **shall** cause no loss of management and user information due to Ground Radio Resource Selection for voice operation.
d) When any PTT is activated, the NEXCOM System **shall** inhibit the Ground Radio Resource Selection for that Talk Group (i.e., inhibit the re-routing of the voice and control signals and inhibit the switching of the antenna transfer relay).

3.2.3.6.7.2 Ground Radio Resource Selection Confirmation

a) The NEXCOM System **shall** provide confirmation of Ground Radio Resource Selection to the Operator (e.g., VSCE, MMCWS, and/or MDT) upon completion of radio selection.

3.2.3.6.7.3 Automatic Ground Radio Resource Switching

a) When the Main and Standby radios are serviced by the same RIU, and so configured, the NEXCOM System **shall** automatically perform M/S radio switching from the selected radio to the alternate radio, without operator intervention, in the event of a failure of the selected radio.

   ***Note** 1: The intent of this requirement is to reduce controller workload by making use of the system's ability to detect and isolate radio failures and switch to the alternate unit, if available and so configured.*
   ***Note** 2: In the case of automatic radio switching upon failure, all User Groups operating on the failed radio will be switched to the alternate radio automatically including, voice, data, and management traffic.*

b) The Automatic Ground Radio Resource Switching **shall** be disabled by subsequent operator manual Ground Radio Resource Selection (i.e., M/S radio selection).
c) If the Automatic Ground Radio Resource Switching is disabled by subsequent operator manual M/S radio selection, the Automatic Ground Radio Resource Switching **shall** remain disabled until manually reset.
d) Automatic Ground Radio Resource Switching **shall** only be performed when the alternate radio is operational.

   ***Note** 3: The Automatic Radio Switching function is intended to apply to both the MDR and the UHF radios connected to the NEXCOM System.*

3.2.3.6.8 Channel Busy Signal

a) The NEXCOM System **shall** provide a Channel Busy signal to the NEXCOM/VSCE interface that indicates the channel keyed by the controller is occupied by a downlink transmission.

***Note** 1: This requirement is needed in support of the voice transmit function of VDL Mode 3 described in RTCA DO-224A Section 3.3.5.4.3.*

3.2.3.6.9 Dual Control

a) The NEXCOM System **shall** provide a dual control priority mode to share control of a Talk Group by two different control facilities.
b) The NEXCOM System **shall** provide a dual control non-priority mode to share control of a Talk Group by two different control facilities.
c) When a denial of access to the radio transmission path condition exists (lockout), as described in subSections 3.2.3.6.9.1 and 3.2.3.6.9.2, the NEXCOM System **shall** send a Lockout signal to the control facility being denied access.
d) The NEXCOM System **shall** provide a PTT/PTT Release Confirmation signal back to the control facility that has access to the radio transmission path.
e) The NEXCOM system **shall** provide to both facilities the availability of communications on the receive path.
f) When the mute function is selected within a control facility, the NEXCOM System **shall** mute the voice receive path for that facility independent of the mute selection of the other facility.
g) When access to the transmission path is gained by one control facility, the NEXCOM System **shall** provide the transmit voice back to the other control facility.
h) Upon the termination of PTT by the control facility that has access to the radio transmission path, the lockout signal to the other control facility **shall** be removed.

***Note**: Dual control is currently employed via the RCE. In this configuration two separate control sites are capable of controlling the same frequency from a single remote site. In the case of priority mode, the higher priority of one facility over the other is determined operationally by the facilities themselves. It is not the function of the NEXCOM System to determine priorities.*

3.2.3.6.9.1 Priority Mode

In this mode, one of the control facilities is designated to be the primary facility by prearrangement.

a) Each control facility **shall** be defined as either a primary or secondary control facility for the paired Talk Group.

***Note**: This means each control facility cannot be primary for one Talk Group and secondary for the other in a paired Talk Group. Paired Talk Groups are commonly composed of a VHF Talk Group and a UHF Talk Group.*

b) When the primary control facility initiates a PTT assertion, the NEXCOM System **shall** provide access to the radio transmission path to the primary control facility.
c) During the conditions outlined in b), the NEXCOM System **shall** lockout the secondary control facility.
d) When the secondary control facility initiates a PTT assertion and the primary control facility has not asserted PTT, the NEXCOM System **shall** provide access to the radio transmission path to the secondary control facility.

3.2.3.6.9.2 Non-Priority Mode

In this mode, both control facilities have equal priority:

a) Neither control facility **shall** be defined as a primary or secondary control facility.
b) When a control facility initiates a PTT assertion and a Voice Preemption assertion during a PTT assertion and a Voice Preemption assertion previously initiated by the other control facility, the NEXCOM System **shall** provide access to the radio transmission path to the control facility that asserted PTT first.
c) During the conditions mentioned in b), the NEXCOM System **shall** lockout the control facility that did not assert PTT first.
d) When a control facility initiates a PTT assertion and a Voice Preemption and the other control facility is not asserting Voice Preemption, the NEXCOM System **shall** provide access to the radio transmission path to the control facility that asserted both.
e) During the conditions mentioned in d), the NEXCOM System **shall** lockout the control facility that did not assert both.
f) When a control facility initiates a PTT assertion and a Voice Preemption and the other control facility is asserting the same signals, the NEXCOM System **shall** provide access to the radio transmission path to the control facility that asserted PTT first.
g) During the conditions mentioned in f), the NEXCOM System **shall** lockout the control facility that did not assert PTT first.

3.2.3.7 Ground Stuck Microphone Correction

a) The NEXCOM System **shall** provide Ground Stuck Microphone Correction, which can be enabled, that disables the uplink transmission for that Talk Group.
b) Ground Stuck Microphone Correction **shall** have a configurable time component, so that when the duration of a PTT signal from a controller exceeds the configured time, transmission stops.
c) During Dual Control operation, the NEXCOM System **shall** reset the timer based on a controller gaining access to the radio transmission path.
d) The NEXCOM System **shall** allow the controller to reinitiate the transmission after Ground Stuck Microphone Correction has disabled transmission by releasing the PTT command and reapplying it.

__Note__ 1: The NEXCOM System indicates the disabling of the transmission to the controller via the removal of PTT Confirmation.
__Note__ 2: Activation of this function will disable PTT and if preempting, will stop the preemption.

3.2.3.8 Telecommunications Links

The following defines the telecommunications requirements needed to support NEXCOM communications between facilities.

3.2.3.8.1 NEXCOM/Telecommunications Interfaces

a) The NEXCOM System telecommunications **shall** provide full-duplex operation.
b) The NEXCOM System **shall** operate with existing 4-wire analog telecommunications and selected digital telecommunications between control and remote radio facilities.

***Note** 1: Information on digital telecommunications for NEXCOM will be defined in the NEXCOM/Telecommunications ICD.*
***Note** 2: The following list is representative of services available. Each has a variation for the characteristics of the service type being ordered.*

- *Leased Interfacility Communications System (LINCS)*
- *FAA Telecommunications Infrastructure (FTI)*
- *The FAA Radio Communications Link (RCL)*
- *The FAA Low Density Radio Communications Link (LDRCL)*
- *The FAA Telecommunications Satellite (FAATSAT) Link*
- *The Alaskan NAS Interfacility Communications System (ANICS)*
- *Federal Telecommunications System (FTS) – 2001 (FTS-2001)*

***Note** 3: The list below is representative of some of the service types offered. Not all the services types listed below are offered by the services listed above.*

- *VG-6 voice grade circuits*
- *VG-8 voice grade circuits*
- *Digital Data Services (DDS)*
- *Direct Digital Connectivity (DDC)*
- *Fractional T-1 (FT-1) or Nx64 kbps*
- *T-1 is T-Carrier at 1.544 Mbps*

***Note** 4: Multiple analog telecommunications circuits may be required to provide sufficient bandwidth to support all four groups of the VDL Mode 3 radio. For example, if only 9600 bps service can be achieved with each available VG-6 circuit, then four or more circuits will be required to support a VDL Mode 3 radio with all of its user groups active.*

c) Analog telecommunications **shall** meet the interface requirements as specified in Telcordia TR-NWT-000335, based on FAA Order 6000.22A.
d) Digital telecommunications **shall** meet the interface requirements specified in Telcordia GR-499-CORE, based on FAA Order 6000.47.
e) The NEXCOM System **shall** support three telecommunication link redundancy configurations:
   1) No backup
   2) Standby Telecommunications backup
   3) Hot telecommunications backup
f) The NEXCOM System **shall** only use the bandwidth from 300 Hz to 3000 Hz for analog telecommunication service.
g) The NEXCOM System **shall** be in compliance with 47 CFR Part 68 regarding c) and d) above.

***Note** 5: Multiple telecommunications circuits may be required to comprise a single telecommunications link. For example, multiple VG-6s may service a single RIU to communicate the different user group information.*
***Note** 6: The hot backup configuration is only applicable when redundant telecommunications are available and the worst-case delay of the links is considered acceptable.*

***Note** 7: The standby backup configuration is applicable when redundant telecommunications are available regardless of the relative delays on the links.*
***Note** 8: VG-8 circuits will not be used for data speeds of less than or equal to 9600 bps unless approved by AOS Branch.*

3.2.3.8.2 Telecommunications Restoration Functional Requirements

The following functional requirements are related to restoration of NEXCOM service between the primary telecommunications link and its backup.

3.2.3.8.2.1 Standby Telecommunications Restoration Functional Requirements

The following functional requirements are related to restoration of NEXCOM service between the primary telecommunications and its backup for the standby telecommunications backup configuration.

a) The NEXCOM System **shall** restore service over the original telecommunications link for telecommunications service interruption of less than 1 second in duration.
b) When a backup telecommunications link is available, the NEXCOM System **shall** have a selectable function to restore service over the backup telecommunications link automatically, upon detection of the primary telecommunications link failure for a telecommunications link service interruption that is 1 second or longer in duration.
c) Upon confirmation of restoration of the primary telecommunications link, and so configured, the NEXCOM System **shall** switch its operation back from the backup telecommunications link to the primary telecommunications link automatically.
d) When both systems are functioning properly, the automatic switch back to the primary telecommunications link **shall** be disabled until the PTT is de-asserted.

3.2.3.8.2.2 Hot Telecommunications Backup Functional Requirements

The following functional requirements are related to NEXCOM service operating with redundant telecommunications while in the hot telecommunications backup configuration.

a) Failure or any performance degradation to either one of the telecommunications interfaces in the hot backup configuration **shall** not degrade the NEXCOM System operation.

3.2.4 Maintenance, Monitoring and Control (MMC) Functional Requirements

The NEXCOM MMC system is based on a three-level hierarchy with the GNI at the top of the hierarchy, the RIU in the middle, and the MDR at the bottom (See Appendix B for the NEXCOM MMC System Hierarchy). Unless otherwise stated the following control and monitoring hierarchy applies:

a) The NEXCOM System **shall** follow the following MMC hierarchy rules for control and monitoring:
    1) Higher level subsystems control and monitor lower level subsystems (i.e., GNI controls and monitors its RIUs and MDRs, and RIU controls and monitors its MDRs).
    2) Equal level subsystems do not control or monitor each other, (e.g., GNIs do not control or monitor each other, RIUs do not control or monitor each other, and MDRs do not control or monitor each other) except as stated in 5 and 6 below.
    3) Lower level subsystems do not control or monitor higher level subsystems (e.g., MDR does not control or monitor the RIU and the GNI) except as stated in 4 below.

4) An RIU can monitor the GNI associated with that particular User Group.
5) An RIU can monitor, through the GNI, it's associated RIU/MDRs at separated sites.

***Note**: Associated RIU/MDRs include diverse units, diversity site units, and separated transmitter/receiver units.*

6) A GNI can monitor GNIs that share use of the same A/G Router.

***Note**: An MDT can access NIMS remotely via a dial up connection from a remote radio site to control the NEXCOM System, provided that the maintenance personnel at the remote site has the proper control authority.*

3.2.4.1 Maintenance Requirements

The following maintenance requirements apply to each NEXCOM Subsystem.

3.2.4.1.1 General Maintenance Requirements

a) The NEXCOM System **shall** meet the hardware maintenance requirements specified in FAA Order 6000.30C, National Airspace System Maintenance Policy.

   ***Note** 1: This policy details a two-level maintenance philosophy: field and depot.*

b) For DSB-AM modes of operation, NEXCOM equipment **shall** be maintained with the support equipment, test equipment, and tools presently in the FAA inventory.

   ***Note** 2: For new modes of operation (i.e., VDL Mode 3), new test equipment is expected to be developed to support maintenance of the equipment.*

c) Individual Lowest Replaceable Units (LRUs) **shall** be designed to permit removal and replacement by a single person.

3.2.4.2 Access

a) Access to MMC functions **shall** be by the following means:
   1) Local MMC Access (see Section 3.2.4.2.1)
   2) Remote MMC Access (see Section 3.2.4.2.2)

   ***Note** 1: See Figures B-6 and B-6a of Appendix B for local and remote relationships in the NEXCOM MMC System Hierarchy.*

b) The NEXCOM System **shall** permit simultaneous monitoring for remote and local access in accordance with Section 3.2.4a).
c) Local control access **shall** automatically inhibit remote control access.
d) The NEXCOM System **shall** provide multiple privilege levels to control access to the NEXCOM MMC.

***Note** 2: This requirement allows the NEXCOM System control of the MMC function to accommodate different classes of users with appropriate MMC capabilities consistent with the assigned responsibilities and to minimize the overall security risk to NEXCOM.*

e) The MMC functions associated with each privilege level **shall** be configurable.
f) The NEXCOM Subsystem **shall** utilize the same data for the local and remote MMC interfaces.

***Note** 3: This prevents different values from being presented to the local and remote MMC interfaces.*

3.2.4.2.1 Local MMC Access

a) The Local MMC Access **shall** provide on-site authorized personnel access to the MMC functions of directly connected NEXCOM Subsystem(s).

3.2.4.2.2 Remote MMC Access

a) The Remote MMC Access **shall** provide authorized personnel access to the MMC functions of indirectly connected NEXCOM Subsystems in accordance with Section 3.2.4a).
b) Remote MMC Access **shall** provide the same functionality and capabilities as local MMC functions except for the local audio interface.

***Note**: NIMS is Remote MMC Access.*

3.2.4.2.3 MMC Access Security

a) The NEXCOM System **shall** support the assignment of a unique logon identifier for each user.
b) The NEXCOM System **shall** authenticate the claimed user's identity before allowing the user to perform any actions.
c) When passwords are used for authentication, the NEXCOM System **shall** use strong passwords (i.e., prevent the use of dictionary words).
d) The NEXCOM System **shall** enforce mandatory password changes at set intervals.
e) The NEXCOM System **shall** prevent the reuse of passwords on a per user basis.
f) The NEXCOM System **shall** execute a defined access control policy.
g) The NEXCOM System **shall** enable access Authorization Management.
h) The NEXCOM System **shall** enforce separation of duties through its role-based ability to restrict users to specific MMC functions, and to specific actions on those objects.

***Note** 1: This requirement is based on the privilege levels.*

i) The NEXCOM System **shall** provide resource allocation features having a measure of resistance to resource depletion (mitigate denial of service attacks).
j) The NEXCOM System **shall** temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.
k) The NEXCOM System **shall** display a configurable banner page upon login.

l) The NEXCOM System **shall** protect information system security data and functionality from all unauthorized access.

Note 2: NIMS access will be limited to monitor access until such time as NIMS complies with security requirements necessary to support NEXCOM security.

3.2.4.2.4 NEXCOM/NIMS Interfaces

a) A NEXCOM/NIMS interface **shall** be at the GNIs with the NIMS agent.
b) A NEXCOM/NIMS interface **shall** be at the A/G Router with a NIMS agent.
c) The NEXCOM System **shall** authenticate all communications between NEXCOM and NIMS.

Note: This includes protection against a replay attack.

d) The NEXCOM System and the NIMS System **shall** provide integrity assurance for the information between NEXCOM and NIMS.
e) The NEXCOM System **shall** assure the integrity of all NEXCOM information being sent to NIMS.

3.2.4.3 Service/System/Subsystem Certification Requirements

a) The NEXCOM System **shall** provide remote monitoring information with sufficient accuracy to verify the correct configuration and operation of each subsystem.
b) The NEXCOM System **shall** provide remote monitoring information with sufficient accuracy to verify the correct configuration and operation of the A/G communications service.
c) The NEXCOM System **shall** periodically verify the following:
    1) Mode of operation
    2) Subsystem configuration
    3) Subsystem/LRU status
    4) Operational status of each Talk Group.
d) The NEXCOM System **shall** provide an alert to the appropriate system managers/logs (e.g., MMCWS, NIMS) if the verification detects an anomaly (e.g., subsystem configured differently than the manager database indicates).

3.2.4.4 System Monitoring Requirements

3.2.4.4.1 Monitored Parameter Status

a) The system/subsystem level parameters to be monitored **shall** include the following:
    1) Ground System Configuration (e.g., Diversity site group operation, VDL Mode 3 System Configuration)
    2) RF Link Status
    3) Telecommunications Status
    4) Subsystem/LRU Status (e.g., Up/Down status for Main/Standby/BUEC elements)
    5) Data Subnetwork Status
    6) Timing Source Status

7) Operational status of each Talk Group (e.g., PTT asserted, Main or Standby Tx and/or Rx selection, etc.)

***Note**: RF Link Status is intended to determine the RF performance of the system to isolate RF performance issues for interference isolation and to help isolate faults within the MDR(s) and for trend analysis.*

b) Upon restoral of connectivity to a remote device, the NEXCOM System **shall** report as alerts to the appropriate system managers/logs (e.g., MMCWS, NIMS) any configuration changes since the last indication.

3.2.4.4.4.1 Performance Status Monitoring

a) The NEXCOM System **shall** collect and present the workload of systems resources.

***Note** 1: The workload is a measurement of the amount of work that a system processed in a specified time period (e.g., voice channel utilization).*

b) The NEXCOM System **shall** collect and present the throughput of system resources.

***Note** 2: The throughput is a measurement of the amount of information that has passed through the system from input to output.*

c) The NEXCOM System **shall** collect and present the response time of system resources.

***Note** 3: The response time is a measurement of the elapsed time for an information item from the time that it has entered into the system to the time that it has completed the process and moved out of the system.*

3.2.4.4.2 Alerting/Alarming

a) System alarms/alerts **shall** be sent automatically to:
   1) The local MMC interface
   2) The remote MMC interface in accordance with Section 3.2.4 a)

***Note**: Alarms indicate when the system is performing outside the normal and alert ranges. An alert is indicated when the unit either changes configuration, or the unit is within the alert range.*

b) A system alarm/alert **shall** automatically trigger the alarm/alert indicator on the front panel of the associated NEXCOM Subsystems.
c) NEXCOM Subsystems **shall** forward any alert/alarm received from a remotely monitored NEXCOM Subsystem according to the NEXCOM MMC System Hierarchy discussed in Section 3.2.4a).

3.2.4.4.3 MMC Data Logging

a) The NEXCOM System **shall** log the following:

1) Alerts
2) Alarms
3) Identification of the system configuration and system components that are changed along with parameter values and the unique identifier of the individual making the change
4) All control access attempts and the unique identifier of the individual making the attempt

***Note**: The NEXCOM Subsystem data logging will be captured in lower level documentation (e.g., SSS).*

b) The NEXCOM System **shall** provide for archiving of log data.
c) The NEXCOM System **shall** time stamp the data log with the time the information was generated by the originating subsystem.
d) The NEXCOM System **shall** protect logs against unauthorized deletion and modification, even by system security administrators.
e) The NEXCOM System **shall** support centralized security incident reporting.

3.2.4.5 System Control Requirements

a) The NEXCOM System **shall** have control functions that allow authorized personnel to adjust designated parameters or exercise designated operational controls for specific subsystems (e.g., Frequency Tuning, VDL Mode 3 System Configuration, and Diversity Site Configuration).
b) The NEXCOM System **shall** terminate control access to any subsystem after a configurable amount of control inactivity.

***Note**: This requirement provides a level of security to the MMC functions.*

3.2.4.6 Fault Isolation Requirements

3.2.4.6.1 Diagnostics and Fault Detection

a) The NEXCOM System **shall** include built-in tests and diagnostic functions to detect equipment failures and isolate equipment faults to the LRU level.
b) Diagnostic results and equipment faults **shall** be available via the local and remote MMC interfaces.
c) At startup of any NEXCOM Subsystem, the system **shall** perform a self-check for the following:
    1) Correct operation of the system
    2) Presence and correct operating capability of the security functions.
d) The NEXCOM System **shall** permit operation of the affected NEXCOM Subsystem(s) only if the self-check function of c) above passes.
e) If the self-check of the security functions of c) above passes, the NEXCOM System **shall** perform all operations.

***Note** 1: Unless the MMC security measures fail, the MMC functionality is always accessible using the appropriate security measures. In cases where the MMC security measures fail and prohibit authorized access, a reset feature should be considered to allow for repair.*

f) The NEXCOM System **shall** include diagnostic functions to automatically detect system anomalies that would interfere with the correct operation, security, and/or maintenance of the system.

Note 2: This is intended to identify system level errors such as configuration mismatches between two devices that communicate.

g) The NEXCOM System **shall** support a commanded operational, security, and maintenance self-test.

Note 3: Detailed self-tests will be further defined in the SSS.
Note 4: Commanded self-tests are intended to provide additional capabilities/information regarding the status of the system/subsystem(s).

3.2.4.6.2 Telecommunications Monitoring

a) The NEXCOM Subsystems that interface with telecommunications functions **shall** detect telecommunications (except MDRs analog interface) link failure.
b) Upon loss of telecommunications service for a site/channel, the affected site/channel **shall** inhibit its RF transmissions automatically.

Note: For sites with redundant telecommunications, all lines for the channel must fail for the RF to be inhibited.

3.2.4.6.3 LRU Addressability

a) Every NEXCOM MMC capable LRU **shall** be uniquely addressable.

Note: NEXCOM MMC-capable LRUs are the LRUs that are accessible by the NEXCOM MMC capability, such as GNI, RIU and MDR.

3.2.4.7 Loss of Input Power

3.2.4.7.1 Momentary Interruption Impact

a) The system/subsystem operation **shall** not be affected by momentary interruptions.

3.2.4.7.2 Power Failure Recovery

a) Upon power restoration, the subsystem **shall** verify proper operation, and (if possible) resume operation.

3.2.4.8 Equipment Hot Swapping

a) The NEXCOM System **shall** support removal and replacement of LRUs without requiring the NEXCOM Subsystems to be powered-down.

3.2.4.9 General Data Interfaces

a) The NEXCOM System **shall** provide general purpose data interfaces for external devices to communicate between an RIU and associated GNI(s).
b) These general data interfaces **shall** have a lower priority than voice, data, or MMC.

3.2.5 Upgradability Functional Requirements

3.2.5.1 System Growth Margin

3.2.5.1.1 I/O Utilization

a) The NEXCOM System **shall** support general purpose discrete Inputs and Outputs (I/Os).

   ***Note**: These discrete I/Os are varying types (e.g., analog, digital, contact closure). These are based on the RCE Technical Instruction Book. The RCE specification is currently being updated to include the utilizations of the discrete I/Os.*

b) The NEXCOM System **shall** allow for selectable monitoring of discrete I/Os.
c) When discrete item monitoring is selected/enabled, the NEXCOM System **shall** generate a user defined MMC message based on I/O state change.
d) The NEXCOM System discrete I/Os **shall** be mappable so that an input at a control site can generate at least one corresponding output at a remote site.
e) The NEXCOM System discrete I/Os **shall** be mappable so that an input at a remote site can generate at least one corresponding output at a control site.
f) The NEXCOM System discrete outputs **shall** be mappable to alert/alarm messages generated within the NEXCOM System (e.g., Telecommunications link failure status generating a discrete output).

3.2.5.1.1.1 Unused Interfaces

a) LRUs **shall** have spare I/O pins available for future expansion as subsystem requirements specify.

3.2.5.1.2 Vocoder

a) The vocoder function **shall** be upgradeable with additional algorithms.

   ***Note**: Vocoder upgrade may involve software changes, or both hardware and software changes. In the case of a hardware upgrade, the changes may include replacement of vocoder chips with newer version chips having compatible pin-out.*

3.2.5.2 Software

a) The NEXCOM System **shall** be upgradeable with new software.

3.2.5.2.1 Software Upgrade

a) An MMC function **shall** be provided to upgrade software by uploading new versions of application or operating system software in accordance with the MMC control hierarchy defined in Section 3.2.4 a).
b) An MMC function **shall** be provided to delete any version of software or operating system software other than the software in operation.

3.2.5.2.2 Software Version Selection

a) An MMC function **shall** be provided that allows the selection of different versions of installed software, should more than one version be present.

3.2.5.2.3 Software Version Switch Failure Reversion

a) Upon failure of switching to a new software version, the device **shall** revert to the previous version of software.

3.2.5.2.4 Software Upload Authentication

a) The NEXCOM System **shall** provide authentication for all software uploads.
b) The NEXCOM System **shall** provide integrity assurance for all software uploads.
c) Software upload attempts **shall** be reported as system alerts to the MMC system for the following modes:
    1) Authentication failure
    2) Data Integrity failure
    3) Successful uploads
d) When software upload failure is detected, the NEXCOM System **shall** reinitiate software upload only upon receiving a new upload command.
e) When software upload failure is detected, the NEXCOM System **shall** delete the failed upload from memory.

3.2.6 System Timing Functional Requirements

The following timing requirements apply:

3.2.6.1 Common Time Conditioning

a) The NEXCOM System **shall** provide a Timing Source.
b) The NEXCOM System **shall** derive system time from the NEXCOM Timing Source per Section 3.3.6.1.1.

    ***Note** 1: System time is applicable to the GNI, RIU and MDR per Section 3.3.6.*

c) The NEXCOM Timing Source **shall** accept conditioning from an external Timing Reference.

    ***Note** 2: It should be pointed out that the telecommunications service might be capable of providing a timing reference for many sites, or be capable of providing a backup timing reference. Care must be taken to ensure that the sites being synchronized trace to the same* *reference, as efforts are made to place RCAG sites in a different Local Access and Transport Areas from their associated BUEC site.*

3.2.6.2 Timing Distribution

a) The NEXCOM System **shall** support multiple collocated RIUs synchronized from a single Timing Source.

***Note**: This is not to introduce a common point of failure to all the affected RIUs. Redundancy of the timing source may be required.*

3.2.7 Reliability, Maintainability, and Availability Functional Requirements

3.2.7.1 Reliability

a) The NEXCOM System **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

3.2.7.1.1 Single Point of Failure

a) No single failure within the NEXCOM System **shall** cause loss of User Group communications.

***Note**: This is derived from NAS-SS-1000, Volume I, par. 3.2.4.1*

3.2.7.2 Maintainability

a) The NEXCOM System **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

3.2.7.3 Availability

a) The NEXCOM System **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

3.2.8 Security Measures

a) The NEXCOM System **shall** log the occurrence of security related events, including attempts to login, attempts of file transfer, and data file modifications.

***Note** 1: This requirement may duplicate other requirements in this document.*

b) The NEXCOM System **shall** alarm upon suspected intrusions.
c) The NEXCOM System **shall** detect malicious code and data (e.g., viruses and worms).
d) The NEXCOM System **shall** provide a means to remove detected malicious code and data (e.g., viruses and worms).
e) The NEXCOM System **shall** support the maintenance of detection and removal functions identified in c) and d) above.
f) The NEXCOM System **shall** generate alerts when file integrity is compromised.

g) The NEXCOM System **shall** implement screening/firewall/proxy server functionality to meet security requirements.

Note 2: This applies to the NEXCOM Subsystems, such as the ATN.

h) The NEXCOM System **shall** provide resource allocation features having a measure of resistance to resource depletion (mitigate denial of service attacks).
i) The NEXCOM System **shall** authenticate all NEXCOM ground communications.
j) The NEXCOM System **shall** provide integrity assurance for the information within NEXCOM.

Note 3: Further detail is provided in the SSS.
Note 4: See Appendix C for further information on security.

3.3 NEXCOM System Performance Requirements

a) The NEXCOM System **shall** meet or exceed the operational coverage area provided by the current analog voice system without degradation of service quality or increase of user workload beyond the workload of the current voice system.

3.3.1 Integration Within the NAS

The following subsections provide the requirements for integration of the NEXCOM System into the NAS.

3.3.1.1 Existing Facility

3.3.1.1.1 Power and Grounding

a) The NEXCOM System **shall** meet the power and grounding requirements of FAA-G-2100G.

3.3.1.1.1.1 Lightning Protection

a) The NEXCOM System **shall** provide lightning and transient protection, and harmonic suppression consistent with ANSI/IEEE Standards C62.36-1994, ANSI/IEEE Standards C62.41-1991, ANSI/IEEE Standards 519-1992, and ANSI/IEEE Standards C62.31-1987, for the following interfaces:
    1) Power
    2) Telecommunications
    3) Antenna

3.3.1.1.2 Physical Requirements

The following requirements apply to all NEXCOM Subsystems unless otherwise noted.

3.3.1.1.2.1 Size

a) Each NEXCOM Subsystem **shall** be 19” rack-mountable into standard Electronic Industries Association (EIA – 310) compliant racks.
b) Each NEXCOM LRU **shall** be no more than 18 inches in depth, including connectors.

c) Each NEXCOM Subsystem **shall** be mounted into a rack(s) that is less than or equal to 84 inches tall.

__Note__: Some NEXCOM Subsystems may be restricted in their allowable depth, which will be identified in the applicable SSS.

3.3.1.1.3 Cable Requirements

a) All NEXCOM cables **shall** meet the performance requirements specified in the following:
   1) NFPA Standard 70, National Electrical Code
   2) FAA Order 6630.4A, En Route Communications Installation Standards Handbook, Chapter 6, Section 3
   3) FAA-C-1217F Electrical Work, Interior

3.3.1.1.4 Environmental and Energy Requirements

The following environmental and energy requirements apply to the NEXCOM System.

3.3.1.1.4.1 Pollution Control Requirements

a) The NEXCOM System **shall** meet the pollution control requirements specified in Executive Order 12088, Federal Compliance with Pollution Control Standards.
b) The NEXCOM System **shall** meet the pollution control requirements specified in Executive Order 13101, Greening the Government through Waste Prevention, Recycling, and Federal Acquisition.
c) The NEXCOM System **shall** meet the pollution control requirements specified in Executive Order 12873, Federal Acquisition, Recycling, and Waste Prevention.
d) The NEXCOM System **shall** minimize the generation of hazardous wastes as defined in 40 CFR 261, Identification and Listing of Hazardous Wastes.

3.3.1.1.4.2 Energy Conservation Requirements

a) The NEXCOM System **shall** meet the energy conservation requirements specified in Executive Order 13123, Greening the Government Through Efficient Energy Management.
b) The NEXCOM System **shall** meet the requirements of Executive Order 12902, Energy Efficiency and Conservation at Federal Facilities.

3.3.1.1.5 Safety Requirements

The following safety requirements apply to the NEXCOM System.

3.3.1.1.5.1 Electrical Safety Requirements

a) The NEXCOM System **shall** meet the personnel safety requirements specified in FAA-G-2100G.
b) Facility electrical modifications to support the NEXCOM System **shall** comply with the requirements of NFPA 70.

3.3.1.1.5.2 Hazardous Materials

a) The NEXCOM System **shall** be free of asbestos, polychlorinated biphenyls (PCBs), lead, and class 1 ozone depleting substances.
b) The NEXCOM System **shall** limit personnel exposure to hazardous materials to the levels permitted by 29 CFR 1910 Subpart Z.

3.3.1.1.5.3 Personnel Safety Requirements

a) The NEXCOM System **shall** comply with the requirements of 29CFR Parts 1910 and 1926.
b) The NEXCOM System **shall** comply with FAA Order 3900.19B.

3.3.1.1.5.4 Seismic Safety

a) New construction supporting the NEXCOM System **shall** be in accordance with 49 CFR Part 41.
b) The NEXCOM System elements installed in existing facilities **shall** be in accordance with FEMA-74.

3.3.1.1.5.5 Equipment Safety

a) Connecting cables consistent with proper operation to or disconnecting cables from equipment in the NEXCOM System while the equipment is powered and the system is in operation **shall** not cause damage to any equipment in the NEXCOM System.

3.3.1.1.5.6 Acoustic Noise

a) The total acoustic noise emanated by the NEXCOM systems that are installed in any locations **shall** not exceed the specifications defined in FAA-G-2100G, Noise Criteria Requirement.

3.3.1.2 Coexistence

3.3.1.2.1 Radio Frequency Interference and Electromagnetic Interference

a) The NEXCOM System **shall** meet the RFI/EMI requirements specified in FAA-G-2100G.

3.3.2 Modes of Operation

3.3.2.1 VDL Mode 3 Standardization

a) The NEXCOM System **shall** meet the VDL Mode 3 performance requirements for ground systems specified in RTCA DO-224A.
b) The NEXCOM System **shall** meet United States regulatory performance requirements specified in, NTIA, etc.
c) When there are conflicts between a) and b) above, the more stringent requirement **shall** take precedence.

3.3.2.2 25 kHz DSB-AM Standardization

a) The NEXCOM System **shall** meet the 25 kHz DSB-AM performance requirements specified in FAA-P-2883 and FAA-P-2884.

3.3.2.3 8.33 kHz DSB-AM Standardization

a) The NEXCOM System **shall** meet the 8.33 kHz DSB-AM performance requirements specified in ICAO Annex 10 and ETSI EN-300-676.

3.3.3 User Group Communications

3.3.3.1 Voice Communications Requirements

The following subsections provide the voice communications requirements for the NEXCOM System.

3.3.3.1.1 Voice Channels

a) The NEXCOM System **shall** support a control facility with at least 350 voice channels per control facility.

__Note__: Many control facilities will not have 350 voice channel capacity, therefore a scalable system has been required in 3.4.3.4.2 b).

3.3.3.1.2 Voice Quality/Intelligibility

a) The NEXCOM System **shall** not degrade the voice quality/intelligibility in a statistically significant manner from the current DSB-AM mode.

3.3.3.1.2.1 Audio Clipping

a) The NEXCOM System **shall** not truncate the voice signal received or transmitted.

__Note__ 1: During Voice Preemption there may be momentary RF contention between voice transmissions until the mobile transmitter can react to the override signaling.
__Note__ 2: This truncation refers to the nulling of the signal especially at the front end of a transmission.

3.3.3.1.3 Audio Throughput Delay

The audio throughput delay is defined as the time it takes for audio to transit through the NEXCOM System when the audio path has already been established, excluding the ground telecommunications circuits.

3.3.3.1.3.1 Uplink Path

a) The uplink audio throughput delay **shall** be no greater than 217 milliseconds (ms) in analog voice mode.

***Note** 1: This requirement pertains to DSB-AM operation through GNI/RIU/MDR equipment. Sustainment delays will be significantly less.*

b) The uplink audio throughput delay **shall** be no greater than 173 ms in digital voice mode.

***Note** 2: A –12 ms adjustment is made to the total budget due to the fact that vocoder frame 1 is to be modulated 12 ms prior to vocoder frame 6 in the MDR.*

3.3.3.1.3.2 Downlink Path

a) The downlink audio throughput delay **shall** be no greater than 175 ms in analog voice mode.

***Note**: This requirement pertains to DSB-AM operation through MDR/RIU/GNI equipment. Sustainment delays will be significantly less.*

b) The downlink audio throughput delay **shall** be no greater than 61 ms in digital voice mode.

3.3.3.2 Data Communications Requirements

The following requirements are only applicable when the NEXCOM System is operating with the VDL Mode 3 service.

The following defines the performance requirements based on Air Traffic Service Communication (ATSC) Classes of Service. If an application is defined to require a specified Class of Service, then the NEXCOM System is to support the performance indicated.

3.3.3.2.1 Data Service

3.3.3.2.1.1 Router Network Size

a) The NEXCOM System **shall** use between 2 and 48 A/G Routers for the NAS.

3.3.3.2.1.2 Minimization of ATN Port Usage

a) The NEXCOM System **shall** provide a data switching function (see Appendix B.3.3) to concentrate GNI connectivity to a limited number of A/G Router ports.

3.3.3.2.1.3 Subnetwork Integrity

a) The NEXCOM subnetwork **shall** guarantee a probability of undetected packet error of less than 10^{-9}.

3.3.3.2.1.4 Subnetwork Transit Delay

a) The NEXCOM System **shall** successfully communicate 95% of the packets from one end of the subnetwork to the other based on the required class of service per Table 3-1.

***Note**: The requirement means that full prioritization will have to be supported by an efficient scheduler.*

Table 3-1

Class and Delay

ATSC Class	Max Subnet 1-way delay 95% (sec)
A	Reserved
B	3.0
C	5.7
D	10
E	14.5
F	23.5
G	46.5
H	96.5

3.3.3.2.1.4.1 Traffic Loading

a) The NEXCOM System **shall** support the traffic identified in Table 3-2 at the specified performance level.

Note 1*: Either this traffic load needs to be run through an A/G Router without the overhead indicated in Note 2 of Table 3-2, or the loading needs to be doubled to approximate the overhead associated with the router.*
Note 2*: For exponential interarrival traffic, a peaking factor of 3 is to be used. This peak traffic will be sustained for a period of 30 seconds. For deterministic traffic, no peaking factor is to be used due to the nature of the traffic.*
Note 3*: Table 3-2 is a representative estimate of the future loading of the system, based on FAA Data Link Operational Requirements Team studies, that is to be used to determine if the system provides sufficient performance. In reality, the traffic loading over time will likely be different. Some modifications were made to transfer some communications to broadcast medium to more efficiently utilize the capacity available.*

Table 3-2

Data Traffic Model

Message Distribution	Priority	Uplink		Downlink	
		average message rate in steady state	average message size in bits	average message rate in steady state	average message size in bits
Exponential inter-arrival with Poisson message size	High	0.017	137	0.024	110
	Medium	0.0017	198	0.0008	100
	Low	0.001	2400	0.002	2400
Constant (Notes 5 & 6)	Low	0.017	3325	0.0033	1760

Notes:
1. Rates are in number of messages per second per aircraft
2. 31 octets of protocol header are added to each message in simulation
3. Each message is acknowledged at Data Link Sublayer except broadcast
4. Ack of uplink message uses downlink M subchannels, ack of downlink message requires 8 octet conveyed in the V/D (data) subchannels
5. Broadcast service is provided for constant uplink messages
6. Periodical fixed size downlink meteorological observations
7. All traffic collectively represents a Load Factor of 1

Ref: A Proposed VDLT Traffic Model for Capacity Simulation, AMCP/WG-D/5 WP-16, 1996

3.3.3.3 Continuous Broadcast

a) The NEXCOM System **shall** operate at up to 100 percent duty cycle in DSB-AM.
b) The NEXCOM System **shall** operate at up to 79.5 percent duty cycle in VDL Mode 3.

3.3.3.4 Connectivity

3.3.3.4.1 RESERVED

3.3.3.4.2 RESERVED

3.3.3.4.3 Subnetwork Leave Event Issuance Delay

a) The NEXCOM System **shall** issue Leave Events to the A/G Router based on the required class of service 95% of the time per Table 3 -3, measured from when the connection is lost to when the Leave Event is sent to the A/G Router. Different performance is specified depending on whether or not data traffic is present.

Table 3-3

Delay With and Without NPDU

ATSC Class	Max Delay Leave Event Issuance in Absence of Network Protocol Data Unit (NPDU) traffic 95% (sec)	Max Delay Leave Event Issuance in Presence of NPDU traffic 95% (sec)
A	Reserved	Reserved
B	27	18
C	44	29
D	81	54
E	108	72
F	162	108
G	300	240
H	> 300	> 240

3.3.3.5 Ground Station Operations

a) The NEXCOM System **shall** support up to four User Groups on the same VDL Mode 3 frequency assignment.
b) Each NEXCOM Talk Group's voice communications resources **shall** be controllable independent from all other Talk Groups' voice communications resources.
c) The NEXCOM System **shall** support operation of multiple ground sites for one User Group in a sector having two to twelve diversely located RCFs.

Note 1: All sites are operating on the same frequency assignment and all using the time slot(s) assigned to the User Group. This includes both voice and data resources depending on the configuration in effect for VDL Mode 3 at the time.
Note 2: The operational configuration stated above refers to the Diversity Site Group operation.
Note 3: In this operation, each site may have unique airspace coverage relative to all other sites but will also have coverage in common with 1 or more other sites.

d) The NEXCOM System **shall** provide uplink M Beacons to all Mobile User within a service volume to maintain timing state TS1 as defined in RTCA DO-224A.

Note 4: A 5.76 second interval allows for the worst-case situation where a particular site ceases beacon transmission. Mobile user radios may delay searching for new beacons for up to 5.76 seconds, thus at least one beacon pair from an alternate site will be available before *a Mobile User radio enters TS2 (approximately 12 seconds after losing the primary beacon signal). This note is based on voice only operation. For data operation see Note 1 above.*

3.3.3.6 NEXCOM System ATC Operational Signaling and Controls

In this section the NEXCOM System Signaling performance requirements are specified. Telecommunications delays are explicitly **not** included in the delay times.

3.3.3.6.1 Push-to-Talk Transmitter Keying (PTT/PTT Release)

a) For VDL Mode 3, the NEXCOM System **shall** transmit/cease transmit audio within 175 ms of the arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.
b) During sustainment, DSB-AM modes of operation using an analog audio interface, the NEXCOM System **shall** transmit RF to 90% output power within 100 ms of the arrival of the PTT signal at the NEXCOM/VSCE interface for 99.9% of the PTT events.
c) During sustainment, DSB-AM modes of UHF radio operation using the analog audio interface, the NEXCOM System RF output **shall** decay to 10% of the set output power within 100 ms of the arrival of the PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the PTT Release events.
d) For DSB-AM modes of UHF radio operation, the NEXCOM System **shall** deliver PTT/PTT Release signal to the RIU/Analog Radio interface within 193 ms of the arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.
e) For DSB-AM modes of UHF radio operation, the NEXCOM System **shall** deliver the PTT signal to the RIU/Analog Radio interface from 15-25 ms before the audio is presented at the interface.
f) For DSB-AM modes of operation using the RIU/MDR Digital interface (using PCM audio), the NEXCOM System **shall** transmit/cease transmit audio within 217 ms of arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.

3.3.3.6.2 PTT/PTT Release Confirmation

a) In DSB-AM modes of UHF radio operation using the RIU/Analog Radio interface, the NEXCOM System **shall** indicate to the NEXCOM/VSCE interface the confirmation of PTT activation received by the RIU from the UHF transmitter within 100 ms for 99.9% of the PTT/PTT Release Confirmation events.
b) The NEXCOM System **shall** indicate to the NEXCOM/VSCE interface the confirmation of audio transmission within 350 ms for 99.9% of the PTT/PTT Release confirmation events.

***Note**: The PTT Confirmation is a continuous indicator with an overall latency of up to 575 ms.*

3.3.3.6.3 Preemption of Mobile Users' Voice Transmissions (Controller Override)

a) The NEXCOM System **shall** initiate transmission of a VDL Mode 3 Voice Preemption signal in the next two scheduled uplink M-burst opportunities for the associated primary and backup radio sites when the condition of simultaneous presence of a Voice Preemption control signal and a PTT control signal occurs at the NEXCOM/VSCE interface.

__Note__ 1: The Voice Preemption should be transmitted in the first available uplink M-burst for the primary and its associated backup radio sites, if possible.

b) The Voice Preemption signal **shall** be contained in the next scheduled uplink Beacon that occurs at least 50 ms after the reception of the Voice Preemption and PTT signals from the NEXCOM/VSCE interface for 99.9% of the preemption events.

__Note__ 2: For diversity site group operation, the scheduled uplink M-bursts will rotate around the various ground stations in the diversity site group to ensure all Mobile Users in the coverage area will receive a Voice Preemption signal.

c) When configured for diversity site group operation and during an attempted Voice Preemption, the NEXCOM System **shall** disable current downlink transmissions with the next uplink M-burst opportunity.

__Note__ 3: This requirement implies that the ground station will change whatever rotation of uplink M-bursts so that the ground station (pair) from which the Mobile User currently is receiving timing will send the next uplink M-burst(s). It may be desirable that the next ground station (pair) be the ground station selected for voice transmission.
__Note__ 4: The timeliness of the Voice Preemption is considered of equal importance to that of the PTT signal.

3.3.3.6.4 Preemption Confirmation of Mobile Users' Voice Transmissions

a) The NEXCOM System **shall** provide, back to the NEXCOM/VSCE interface, confirmation of Voice Preemption activation within 350 ms of its transmission for 99.9% of the events.

__Note__: The timeliness of the Voice Preemption indication is considered of equal importance to that of the PTT confirmation.

3.3.3.6.5 Squelch Break

a) The NEXCOM System **shall** indicate to the NEXCOM/VSCE interface squelch breaks in the receiver within 100 ms for 99.9% of the squelch break indication events.

__Note__ 1: Squelch break is a continuous indicator with an overall latency of up to 350 ms.
__Note__ 2: The timeliness of the squelch break indication is considered of equal importance to that of the Channel Busy signal, as some regions use this signal to route audio.

3.3.3.6.6 Received Audio Muting

3.3.3.6.6.1 PTT Mute/Attenuation

a) For DSB-AM modes of operation, the audio attenuation **shall** be configurable for 0, 15, or 20 dB.
b) For DSB-AM modes of operation, the audio attenuation delay **shall** be configurable in duration from 0 to 600 ms, in 10 ms, increments after release of PTT at the remote site.

3.3.3.6.6.2 Commanded Mute/Unmute

a) The NEXCOM System **shall** mute/unmute the received audio within 105 ms for 99.9% of the Commanded Mute/Unmute events.

3.3.3.6.6.3 Commanded Mute/Unmute Confirmation

a) The NEXCOM System **shall** provide Commanded Mute/Unmute Confirmation to the NEXCOM/VSCE interface within 350 ms for 99.9% of the Commanded Mute/Unmute events.

3.3.3.6.7 Ground Radio Resource Selection and Switching

3.3.3.6.7.1 Ground Radio Resource Selection

a) The NEXCOM System **shall** select radio resources (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary) within 100 ms of receipt of the signal from the NEXCOM/VSCE interface for 99.9% of the Ground Radio Resource Selection events.

3.3.3.6.7.2 Ground Radio Resource Selection Confirmation

a) The NEXCOM System **shall** confirm Ground Radio Resource Selection (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary)within at most 250 ms from the time of switching for 99.9% of the Ground Radio Resource Selection events.

   Note*: The radio resource selection confirmation has an overall latency of up to 425 ms from generation to display at the controller.*

3.3.3.6.7.3 Automatic Ground Radio Resource Switching

a) The NEXCOM System **shall** switch from the failed radio to the operational alternate radio and be ready to operate over the alternate radio within 30 ms after detection of the radio failure.

   Note*: This does not apply to legacy radios.*

3.3.3.6.8 Channel Busy Signal Performance

The Channel Busy signal is an indicator to the controller that a channel is not available. It is an indicator that is a feedback to a controller action, and it is a factor in the operational suitability of the system. An overall latency of 300 ms appears suitable, of which 125 ms can be allocated to the NEXCOM System.

a) The NEXCOM latency for the Channel Busy indicator **shall** be at most 125 ms for 99.9% of the channel busy events.

3.3.3.6.9 Dual Control

a) The NEXCOM latency for the VHF/UHF Lockout indicator **shall** be at most 125 ms for 99.9% of the lockout events.

3.3.3.7 Ground Stuck Microphone Correction

a) The Ground Stuck Microphone timeout **shall** be configurable to be enabled or disabled.
b) The Ground Stuck Microphone timeout, when enabled, **shall** be configurable from 5 seconds to 5 minutes in 5 second increments.

3.3.3.8 Telecommunications Links Performance

The NEXCOM Telecommunications performance requirements are defined below:

3.3.3.8.1 Telecommunications Delay and Delay Variations

a) The NEXCOM System **shall** operate when the telecommunications one-way delay is up to 600 ms.

   Note *1: It is desirable to limit one-way transfer delay to a minimum and below 25 ms. There are, however, circumstances that longer-delay telecommunication links, e.g., satellite links, are the only viable alternatives. The worst-case delay scenario defined for the NEXCOM System is for a double satellite hop link with a maximum transfer delay of 600 ms (as defined by ANICS).*

b) The NEXCOM System **shall** operate with transfer delay variations.

   Note *2: Variations may be due to line switching, packet path variations, or clock slips.*
   Note *3: The extent of the variation will be addressed in future documentation.*

c) The NEXCOM System transfer delay **shall** be minimized based on the characteristics of the telecommunications media.

   Note *4: When excessive delay characteristics exist in the NEXCOM System, special operational conditions usually exist such as low-density airspace.*

3.3.3.8.2 Telecommunications Restoration Performance

The following are performance requirements associated with telecommunications restoration:
a) The restoration time, defined to be the combined time to detect the link failure, to transfer operation to a backup link, and to restore operations, **shall** be 6 seconds or less.

   Note*: The conditions for declaring link failure will be defined in the NEXCOM/ Telecommunications ICD.*

b) For telecommunications service interruption of less than 1 second in duration, the NEXCOM System **shall** restore the communications service within 120 ms after the condition that caused the service interruption is removed.
c) The NEXCOM System **shall** switch its operation from the backup telecommunications link to the primary telecommunications link within 3 seconds after the PTT is de-asserted upon restoration of the primary telecommunications link, without loss of data.

3.3.3.8.2.1 Standby Telecommunications Restoration Performance

a) When a backup telecommunications link is available and the NEXCOM System is in the standby telecommunications backup configuration, the NEXCOM System **shall** restore operation from the primary telecommunications link to the backup telecommunications link in 1 second or less after detection of the primary telecommunications service failure.

   ***Note**: A telecommunications service failure is defined as a telecommunications service interruption of 1 second in duration.*

b) When configured for standby telecommunications backup after the primary link has failed, the NEXCOM System **shall** switch its operation from the backup telecommunications link to the primary telecommunications link within 3 seconds after the primary telecommunications link is restored, without loss of data.

3.3.4 Maintenance, Monitoring and Control (MMC) Performance Requirements

3.3.4.1 Maintenance Requirements

3.3.4.1.1 LRU Maintenance

a) Maintenance of individual LRUs **shall** meet the requirements specified in FAA-G-2100G.

   ***Note**: LRU weight is to be defined in the SSS using FAA-G-2100G Section 3.3.6.3 as guidance.*

3.3.4.1.2 Non-Interference MMC

a) The NEXCOM MMC function **shall** not degrade system performance unless a commanded self-test, supported in Section 3.2.4.6.1 h), requires that the NEXCOM System temporarily prohibit operational use for the thread(s) under test.

   ***Note**: The NEXCOM MMC function should not impact the performance of a thread under any condition, but an exclusion is made to allow the NEXCOM System to enter a more comprehensive testing state where the operation, exclusive to the thread(s) under test, may or may not be impacted depending on the design and the confidence level associated with the test.*

b) The failure of any MMC function **shall** not degrade the NEXCOM System User Group communication.
c) NEXCOM MMC monitoring messages **shall** not prevent the communication or processing of NEXCOM MMC control messages.

3.3.4.2 NIMS Interface

a) The NEXCOM System **shall** provide at least 8 privilege levels for access to the NEXCOM MMC.

3.3.4.3 RESERVED

3.3.4.4 System Monitoring Requirements

3.3.4.4.1 Monitored Parameter Status

a) All data provided in response to maintenance or monitoring inquiries **shall** be less than 2 seconds old on average at the time of response, with a maximum of 4 seconds.
b) The response **shall** be sent within 2 seconds average, 4 seconds maximum, after receipt of the inquiry. The time is measured from the time the managed subsystem receives the last byte of the data request to the time that the managed subsystem transmits the first byte of the response.

3.3.4.4.2 Alerting/Alarming

a) All data provided in alerts and alarms **shall** be less than 2 seconds old on average at the time of generation, with a maximum of 4 seconds.

3.3.4.4.3 MMC Data Logging

a) The NEXCOM System **shall** have 30 days of storage capacity for data logging entries to support diagnostics, and configuration management, without archival.
b) New data **shall** over-write the oldest unprotected data when the storage capacity is reached for non-archived data.

   Note: *This implies that the NEXCOM System can protect non-archived data.*

c) The NEXCOM System **shall** automatically archive log entries that are older than 25 days.
d) The NEXCOM System archival function **shall** not over-write existing log data.

3.3.4.5 System Control Requirements

a) The NEXCOM subsystem **shall** complete the task of executing a change of a MMC parameter command within 1 second average, 3 seconds maximum, after receiving the command.

   ***Note** 1: The process time is measured from the time the managed subsystem receives the last byte of the control command to the time that the managed subsystem transmits the first byte of the response or acknowledgment.*
   ***Note** 2: The switch software version command is not applicable under this requirement.*

3.3.4.5.1 Frequency Range

a) The NEXCOM System **shall** provide communications services in the range of 112 -137 MHz.
b) The NEXCOM System **shall** provide selectable lock out of the band from 112-117.975 MHz to prevent accidental tuning into the band prior to reallocation of portions of or the entire band for ATC use.

***Note**: It is anticipated that the NEXCOM System will operate initially on the 118 – 136.975 MHz assigned channels.*

3.3.4.5.2 RF Power Output

a) The RF output power of the NEXCOM System **shall** be adjustable from 2 to 50 watts (33 dBm to 47 dBm).

***Note**: The RF power range applies to all NEXCOM System modes.*

3.3.4.6 RESERVED

3.3.4.7 System Startup

a) The NEXCOM System **shall** be operational within 5 minutes of applying power to the system components (subsystems).

***Note**: In the process of applying power to the subsystems, the subsystems are powered in some (random) sequence. The 5 minute requirement is applicable from the instant power is applied to the last subsystem.*

b) Each NEXCOM Subsystem **shall** be operational within 5 minutes of applying power.

3.3.4.8 RESERVED

3.3.4.9 General Data Interfaces

a) The NEXCOM System **shall** provide the three general data interfaces with a maximum communication rate possible according to the available bandwidth.

***Note**: The bandwidth available is in accordance to earlier references, is dependent on the Telecommunications interfaces specified in Section 3.2.3.8.1, and the usage of the bandwidth by the normal operation of the NEXCOM System (priority scheme considered).*

b) The general data interfaces **shall** not degrade system performance.
c) The failure of any general data interface **shall** not degrade the NEXCOM System User Group communication.

3.3.5 Upgradability Performance Requirements

3.3.5.1 System Growth Margin

The NEXCOM System will be implemented with excess computational capacity such that the initial utilization of the NEXCOM System for both voice and data resources does not exceed the levels in the following paragraphs.

The margin is for those requirements actually required by the initial system and does not include future expansion options identified, such as system configuration 3T.

3.3.5.1.1 Discrete I/O Utilization

a) The NEXCOM System **shall** provide an output state change within 500 ms of the state change at the input for 99.9% of the discrete I/Os state change events, when so configured.

3.3.5.1.1.1 Unused Interfaces

a) Internal and external interfaces, which are not required for operations, **shall** not degrade system operations or performance, regardless of whether they are activated or deactivated, open or terminated.

Note 1: This requirement intends to cover all interfaces that are used for MMC, including equipment internal or external test points, headphone connectors for local audio monitoring, microphone/PTT interface for local audio injection, MDT interfaces.

b) Unused interfaces, which are deactivated from operational use, **shall** not degrade system operations or performance, regardless of whether they are open or terminated.

Note 2: This requirement is for interfaces that are intended for operational support but are not currently selected for use. For example, either the analog voice interface or the digital interface between RIU and MDR is activated, depending upon system configuration, and the deactivated interface should not degrade system operations or performance, regardless of whether it is terminated or not.

3.3.5.1.1.2 NEXCOM System Throughput

a) I/O throughput provided **shall** have room for future expansions.
b) The NEXCOM System **shall** operate with full occupancy of all voice and data slots.

3.3.5.2 Software

3.3.5.2.1 Memory

The following memory requirements apply to each of the NEXCOM Subsystems.

Note: These requirements include memory built into processor devices.

3.3.5.2.1.1 Random Access Memory

a) The subsystems, as initially implemented, **shall** utilize less than 50% of the total available RAM.

3.3.5.2.1.2 Non-Volatile Memory

a) The subsystems, as initially implemented, **shall** utilize less than 50% of the total available non-volatile memory.

3.3.5.2.2 Processor Utilization

a) The utilization of all programmable processors and devices (e.g., Field Programmable Gate Arrays) **shall** not exceed 50 % of the maximum capacity of the device(s) as initially implemented.

3.3.6 System Timing Performance Requirements

The following timing requirements apply.

3.3.6.1 Common Time Conditioning

3.3.6.1.1 Timing Accuracy

a) When the NEXCOM System is operating in VDL Mode 3 under normal operating conditions, the RF transmissions emanating from the NEXCOM System **shall** not be more than ± 23.55 µs from their scheduled event time with respect to the Timing Standard specified in Section 3.3.6.3.
b) When the NEXCOM System is operating in VDL Mode 3 with loss of the Timing Reference, the RF transmissions emanating from the NEXCOM System **shall** not be more than ± 190 µs from their scheduled event time with respect to the Timing Standard specified in Section 3.3.6.3 and the Timing Drift period specified in Section 3.3.6.2.

__Note__: See Appendix G for an explanation of the timing synchronization requirements.

3.3.6.2 Timing Drift

a) With the loss of external Timing Reference conditioning, the Timing Source **shall** maintain system timing for at least 30 days without degrading system operation due to timing.

__Note__: See Appendix G and requirement 3.3.6.1.1 b).

3.3.6.3 Timing Standard

a) The Timing Source **shall** be aligned with UTC on 6 January 1980.

__Note__: The above requirement implies that leap seconds are not compensated for, as leap second adjustments would perturb the operation of the system. GPS is one system that is aligned with UTC on 6 January 1980. Any other absolute time source which is traceable to UTC without leap second adjustments is also suitable as an external Timing Reference for VDL Mode 3.

3.3.7 Reliability, Maintainability, and Availability Performance Requirements

3.3.7.1 Reliability

3.3.7.1.1 NEXCOM Mean Time Between Outages (MTBO)

a) The MTBO of the NEXCOM Subsystem at an RCAG **shall** be greater than or equal to 19,996 hours.

__Note__: This requirement provides a constraint on the allocation of MTBF to subsystem elements to meet the service availability. Further information on how this is used is contained in Appendix E.

3.3.7.2 Maintainability

3.3.7.2.1 NEXCOM Mean Time to Restore (MTTR)

a) The NEXCOM RCAG MTTR, as defined by FAA Order 6040.15C, par. 702f **shall** be less than or equal to 0.5 hours.

__Note__ 1: This is derived from NAS-SS-1000, Volume I, par. 3.2.2.3.
__Note__ 2: MTTR is defined to start from the time the service personnel arrives at the site and specifically excludes travel time.
__Note__ 3: The MTTR calculation assumes a single LRU failure and includes the time to isolate the failure to a specific LRU, replace it and return it to service.

3.3.7.2.2 Periodic Maintenance

a) The equipment **shall** require on-site periodic maintenance no more than once per year.
b) Periodic maintenance tasks **shall** require no more than one person to accomplish.

__Note__ 1: This is derived from NAS-SS-1000, Volume 1, par. 3.2.3.2.

c) Time to complete periodic maintenance tasks **shall** be equal to or less than existing equipment and require no more than 12 staff hours per year in accordance with NAS-SS-1000, Volume I, par. 3.2.3.2.

__Note__ 2: Requirement c) is derived from NAS-SS-1000, Volume I, par. 3.2.3.2.

3.3.7.3 Availability Requirements

3.3.7.3.1 Voice Service Availability

a) The NEXCOM voice service availability, as defined by FAA Order 6040.15, par. 702c, **shall** be 0.99999 or greater.

3.3.7.3.2 Data Service Availability

a) The NEXCOM data service availability, as defined by FAA Order 6040.15, par. 702c, **shall** be 0.99999 or greater.

3.3.7.3.3 Equipment Availability

a) The NEXCOM System equipment **shall** have an inherent availability of .999975 or greater in accordance with NAS-SS-1000, Volume I, par. 3.2.4.

Note: This requirement implies that each subsystem must have an MTBF of at least 19,996 hours.

3.4 Subsystem Functional Allocations

The NEXCOM Subsystem functional requirements are described in the following subsections.

3.4.1 MDR Functional Requirements

The following functional requirements apply only to MDR transmitter and MDR receiver subsystems.

3.4.1.1 MDR Sustainment Operation

a) The NEXCOM MDR subsystems **shall** meet the functional requirements specified in the following:
   1) FAA-P-2883, Purchase Description, VHF/UHF Air/Ground Communications Receiver
   2) FAA-P-2884, Purchase Description, VHF/UHF Air/Ground Communications Transmitter

3.4.1.2 MDR Subsystem Functions

a) MDR transmitter subsystems **shall** provide the functions listed in Table 3-4.

Table 3-4

MDR Transmitter Functions

Functions
1. Physical Layer
a) Synchronization sequence generation
b) Gray code encoding
c) Differential encoding
d) Bit scrambling
e) Golay Forward Error Correction (FEC) encoding
f) RF Output Power Control
g) Channel tuning
h) Modulation
2. Built-in-Test
3. Programmability
4. Local MMC

b) The MDR receiver subsystems **shall** provide the functions listed in Table 3-5.

Table 3-5

MDR Receiver Functions

Functions
1. Physical Layer
a) Synchronization sequence detection
b) Gray code decoding
c) Differential decoding
d) Bit descrambling
e) Golay FEC decoding
f) Channel tuning
g) Demodulation
2. Other Functions in Receiver
a) Squelch windowing
b) Squelch timing enforcement
c) Voice header identification
3. Built-in-Test
4. Programmability
5. Local MMC

3.4.1.3 MDR Subsystem Interfaces

a) The MDR transmitter and MDR receiver units **shall** have the following interfaces:
   1) MDR/RIU Digital interface
   2) MDR/MDT interface
   3) MDR/RCE interface
   4) MDR/Antenna interface
   5) MDR/MDR RF-to-RF interface

3.4.1.4 MDR Human Interfaces

a) Each MDR transmitter **shall** include an on/off power switch.
b) Each MDR transmitter **shall** include a front panel display of the frequency, equipment state, and mode of operation.
c) Each MDR receiver **shall** include an on/off power switch.
d) Each MDR receiver **shall** include a front panel display of the frequency, equipment state, and mode of operation.

3.4.1.5 MDR System Timing

a) The MDR **shall** derive all necessary VDL Mode 3 TDMA timing using the information received from the RIU.

3.4.1.6 MDR Reliability/Maintainability

a) The MDR **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

3.4.2 RIU Functional Requirements

The following functions apply only to the RIU subsystem.

3.4.2.1 RIU Subsystem Functions

3.4.2.1.1 RIU Physical Layer Functions

a) The RIU **shall** encode and decode Reed-Solomon (72, 62) codewords for VDL Mode 3 data burst operation per RTCA DO-224A, Section 3.3.1.3.3.3.

3.4.2.1.2 RIU Media Access Control (MAC) Functions

a) The RIU **shall** implement the ground portion of the VDL Mode 3 MAC sublayer for voice, data and management functions as defined in RTCA DO-224A Section 3.3.2.1, except for requirements related to system configurations 3T, 3S and 2S1X.

   Note: *System configurations 3T, 3S and 2S1X are exempted from the initial implementation, but provide them as an upgrade capability.*

b) The RIU MAC sublayer **shall** be upgradeable to support all other VDL Mode 3 system configurations.

3.4.2.1.3 RIU Subsystem VDL Mode 3 Data Link Service (DLS) Functions

a) The RIU **shall** provide the DLS acknowledgment (ACK) processing and priority queuing functions as defined in RTCA DO-224A, Section 3.3.2.2.
b) The RIU **shall** perform error detection and address identification (ID) on all DLS frames received from an MDR receiver as defined in RTCA DO-224A, Section 3.3.2.2.1.

3.4.2.1.4 RIU Link Management Entity (LME) Functions

a) The RIU **shall** provide the following LME functions as defined in RTCA DO-224A, Section 3.3.2.3, for all VDL Mode 3 system configurations except 3T, 3S, and 2S1X:
   1) Net Initialization
   2) Net Entry
   3) Link Maintenance (e.g., polling)
   4) Link Release
   5) Expedited Recovery

   Note: *System configurations 3T, 3S, and 2S1X are exempted to simplify the initial implementation, yet provide them as an upgrade capability.*

b) The RIU LME **shall** be upgradeable to support all other VDL Mode 3 system configurations.

3.4.2.2 RIU Subsystem Communication Functions

3.4.2.2.1 Air/Ground Voice and Data

3.4.2.2.1.1 RIU Subsystem Voice Operation

3.4.2.2.1.1.1 RIU Subsystem PCM Voice Operation

a) The RIU **shall** use Pulse Code Modulation (PCM) to communicate audio with the MDR transmitter and receiver for DSB-AM modes of operation.

Note: Refer to the RIU/MDR ICD for PCM Voice format.

3.4.2.2.1.1.2 RIU Subsystem Vocoder Operation

a) The RIU **shall** vocode audio between the GNI and the DSB-AM transmitter and receiver.

Note 1: This capability supports UHF radios when the VHF service is supporting VDL Mode 3, as well as the rare case when the GNI-RIU is supporting DSB-AM service for both VHF and UHF.

b) The RIU **shall** support both normal voice and downlink truncated voice data rates.

Note 2: This requirement is to ensure that the ground station can provide received truncated voice to the controller in cases where the Mobile User comes into coverage in the middle of a voice transmission.

3.4.2.2.1.1.3 Simultaneous Downlink UHF/VHF Voice

a) When the RIU is supporting DSB-AM modes of operation for VHF, the RIU **shall** conference/sum audio received from the selected and unmuted VHF and UHF receivers.
b) When downlink activity is present on both VHF and UHF Talk Groups, the RIU **shall** be configurable to communicate both audio conversations to the GNI.

The following only applies when the RIU is configured to send only VDL Mode 3 VHF voice or UHF voice at a single time:

c) If a downlink UHF voice reception begins while a downlink VDL Mode 3 voice reception is in progress, the RIU **shall** notify the GNI of the UHF reception and drop the UHF reception until the VDL Mode 3 downlink voice reception terminates.
d) If a downlink VHF VDL Mode 3 voice reception begins while a downlink UHF voice reception is in progress, the RIU **shall** send the Mobile User ID associated with the VDL Mode 3 reception to the GNI and drop the VDL Mode 3 voice reception until the UHF downlink voice reception terminates.

3.4.2.2.1.2 RIU Subsystem Data Operation

3.4.2.2.1.2.1 RIU Subsystem VDL Mode 3 Data Operation

a) For VDL Mode 3 data operation, the RIU **shall** schedule data access per the Manual for the Implementation of VDL Mode 3, Section 4.9.

Note 1: For diversity site group operations with respect to Section 4.9 of the referenced Manual, voice preemption signaling will also contend for M uplink channel resources and may complicate scheduling.

b) The RIU **shall** provide means whereby the maintenance personnel can prevent the use of the Main or Standby resources for data operation.

***Note 2**: This is so that the technicians can perform maintenance on a portion of the system without interrupting the operation of the system.*

c) Upon enabling or disabling of the maintenance restriction of b), the RIU **shall** maintain data flow without interruption.

3.4.2.3 RIU Local Maintenance, Monitoring and Control

a) The RIU **shall** interface to a local Maintenance Data Terminal to allow local control of the RIU.
b) The RIU **shall** allow the locally connected MDT to remotely control all attached MDRs and all attached UHF radios.
c) The RIU **shall** only accept local control commands from an authenticated MDT.
d) The RIU **shall** support the MDT's multidrop RIU access per Section 3.4.5.2 b).
e) The RIU **shall** allow monitoring of its User Group resources in the GNI and at its backup sites, from its MDT port.

3.4.2.3.1 RIU Front Panel Control and Monitoring

a) The RIU **shall** provide front-panel access to limited MMC capabilities to include:
   1) Local Audio provision with independent volume control and slot selection
   2) Status and Configuration Display.

***Note**: Local audio provision is the ability to input analog audio into the RIU and radiate out the MDR, as well as monitoring GNI communications.*

3.4.2.3.2 RIU Telecommunications Monitoring

a) The RIU **shall** inhibit RF transmissions upon detection of the loss of telecommunications service.

***Note**: For dual control operation, this requires the loss of both control site connections.*

3.4.2.4 RIU Subsystem Interfaces

a) The RIU **shall** have the following interfaces:
   1) RIU/Analog Radio Interface (see Section 3.4.2.4.6)
   2) RIU/MDR Digital Interface (see Section 3.4.2.4.7)
   3) RIU/MDT Interface (see Section 3.4.2.3)
   4) RIU/Timing Source Interface (see Note)
   5) RIU/Telecommunication Link interface to GNI (see Section 3.4.2.4.1)
   6) RIU/GNI Interface (see Section 3.4.2.4.2)

7) General Data Interface (see Section 3.4.2.4.3)
8) Human Interface (see Section 3.4.2.4.4)
9) Power Interface (see Section 3.4.2.4.5)

Note: *The RIU/Time source interface may be internal to the RIU.*

3.4.2.4.1 RIU/Telecommunications Interfaces

a) The RIU **shall** interface with at least a 56 kbps digital service via a DDC interface to access the remote GNI.
b) The RIU **shall** support usage of analog 4-wire VG-6 ground telecommunications circuits to access the remote GNI when the digital interface is not being used.
c) The RIU **shall** support usage of analog 4-wire VG-8 ground telecommunications circuits to access the remote GNI when the digital interface is not being used.
d) The RIU **shall** support telecommunications interfaces to provide dual control over redundant telecommunications links.

***Note** 1: The telecommunications interfaces may be on dissimilar media.*

e) When configured for standby telecommunications backup, the RIU **shall** detect transmission path failures (defined as an inability to communicate with a GNI for a 1 second period), causing a switch to an alternate transmission path to restore communications to the GNI.

***Note** 2: This assumes the presence of an alternate telecommunications path to the RIU. It is recognized that not all sites have this alternate telecommunications path.*

f) When configured for hot telecommunications backup with a GNI, the RIU **shall** simultaneously communicate over the redundant telecommunications interfaces with that GNI.
g) When configured for hot telecommunications backup with a GNI, the RIU **shall** be able to use information from either interface without interfering with the operation of the communications system.
h) When configured for standby telecommunications backup with a GNI, the RIU **shall** communicate over at least one telecommunications interface with that GNI.

3.4.2.4.2 RIU/GNI Interfaces

a) For dual control the RIU **shall** interface with two GNIs via RIU/Telecommunications interface(s) and/or direct connectivity.

3.4.2.4.3 General Data Interfaces

a) The RIU **shall** provide at least three RS-232 serial communications interfaces for general data interfaces to external devices.
b) These general data streams **shall** have a lower priority than voice, data, or MMC.

3.4.2.4.4 RIU Human Interfaces

a) The RIU **shall** include an on/off power switch.

b) The RIU **shall** include a front panel display of the frequencies for each associated radio, system configuration, equipment state, and mode of operation of the RIU.

3.4.2.4.5 Power Interfaces

a) The RIU **shall** interface with existing power in NAS facilities consistent with FAA Order 6950.2D.

3.4.2.4.6 RIU Analog Radio Interfaces

a) The RIU **shall** interface with up to four channels of existing analog UHF radio equipment, including Main/Standby Transmitter/Receiver units.

__Note__ 1: This implies up to 8 UHF transmitters and 8 UHF receivers.

b) The RIU **shall** use the digital audio signal from the GNI to drive the audio input of the analog voice radios.
c) The RIU **shall** provide connections to each of the UHF radio's RMMC ports.

__Note__ 2: This requirement is to be applicable to the new UHF radio being procured by the FAA in the 2003 time frame. The protocol is being specified in the ICD yet to be written.

3.4.2.4.7 RIU/MDR Digital Interfaces

a) An RIU **shall** support up to two MDR transmitters and two MDR receivers.

3.4.2.5 Signaling

a) The RIU **shall** mute the received audio of the UHF and/or VHF radios when so commanded.
b) The RIU **shall** be configurable to either pass through an MDR generated PTT/PTT Release Confirmation signal or generate the signal locally per c).
c) The RIU **shall** utilize the receiver to loop back the transmitted audio to determine the RIU-generated PTT/PTT Release Confirmation signal.

__Note__: This capability will not be available to all configurations of the NAS, as not all sites allow the receiver to hear the transmitter.

d) The RIU **shall** use the End of Message (EOM) bit or lack of voice messages to indicate squelch break inactive, while operating in VDL Mode 3.
e) The RIU **shall** use signaling information from the GNI to select the active MDR and UHF radio units.
f) When any PTT is activated, the RIU **shall** inhibit the main/standby (M/S) select function for that frequency (i.e., inhibit the re-routing of the voice and control signals and inhibit the switching of the antenna transfer relay).
g) When the RIU is operating in Dual Control mode and when another user gains access at the RIU, the RIU **shall** pass a Lockout signal back to the other user's GNI to indicate when access to the RIU is not available.

3.4.2.6 RIU Reliability/Maintainability

a) The RIU **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

3.4.2.7 RIU Site Configuration

a) The RIU **shall** support a configuration with a common RIU supporting the transmitters and receivers associated with a User Group.
b) To support separate transmitter and receiver sites, the RIU subsystem **shall** support a split-RIU configuration where RIU devices are located at each of the separated sites.

Note: *The split-RIU configuration is envisioned to reduce telecommunications requirements and provide better information security to the system than a seperate RIU/MDR link. It is recognized that some of the VDL Mode 3 protocol default parameters may have to be adjusted for this configuration to account for the increased delay while the RIUs are coordinating net entries and data transfers.*

3.4.2.8 RIU System Timing Source

a) The RIU **shall** provide timing to the MDR transmitters and receivers.

Note 1: This timing is to allow for intersite synchronization to prevent interslot interference.

b) The RIU **shall** provide timing to the GNI.

Note 2: This timing is to allow the GNI vocoders to track the VDL Mode 3 timing to minimize end-end voice delay.

c) The RIU **shall** report the status of the Timing Source to the MMC function.

3.4.3 GNI Functional Requirements

The following functions apply only to GNI subsystems.

3.4.3.1 GNI Subsystem Functions

3.4.3.2 GNI Subsystem Communication Functions

3.4.3.2.1 Air/Ground Voice and Data

a) The GNI **shall** multiplex voice and data for transmission to the appropriate ground station RIU.

3.4.3.2.1.1 GNI Subsystem Voice Operation

When supporting voice operations, the following apply:
a) The GNI **shall** encode/decode speech using the vocoder specified in ICAO Annex 10, Vol. III, Part 1, Chapter 6, for each Talk Group.

3.4.3.2.1.2 GNI Subsystem Data Operation

3.4.3.2.1.2.1 VDL Mode 3 Data Operation

a) The GNI **shall** provide VDL Mode 3 Packet Layer Protocol (PLP) compression, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3 and Appendix J.
b) The GNI **shall** provide CLNP frame mode compression, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3, and Appendix K.
c) The GNI **shall** provide raw subnetwork interface data transfer services for non-ATN messaging, as defined in RTCA DO-224A, Section 3.3.3.
d) The GNI **shall** provide IEC/ISO 8208 data transfer services, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3.
e) The GNI **shall** provide CLNP data transfer services, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3.
f) The GNI **shall** be upgradeable to provide ATN Frame Mode subnetwork interface data transfer services, as requested by Mobile Users, as defined in Change 1 to RTCA DO-224A, Section 3.3.3.
g) The GNI **shall** provide MbB services as defined in RTCA DO-224A, Section 3.3.3.3.

***Note** 1: The GNI should minimize the transit delay associated with the handoff between A/G Routers.*
***Note** 2: The GNI should minimize the channel blockage associated with the handoff between A/G Routers.*
***Note** 3: Section 3.2.3.2.1.1 applies during handoffs as well to establish a maximum acceptable level.*

h) The GNI group **shall** report to the A/G Router only those connectivity changes to the subnetwork that affect A/G Router connectivity decisions, as defined in RTCA DO-224A, Section 3.3.2.3.

***Note** 4: A GNI group is a collection of interconnected GNIs that interface to a single A/G Router port.*

i) The GNI **shall** not permit any of its functions or components to be used to access unauthorized parts of the NAS external to the NEXCOM System.

3.4.3.3 GNI Subsystem Remote Maintenance, Monitoring and Control Functions

3.4.3.3.1 GNI Subsystem Remote Monitoring Functions

a) The GNI **shall** monitor the functional status of its associated RIUs.
b) The GNI **shall** monitor the functional status of its associated Timing Sources.
c) The GNI **shall** monitor the functional status of its associated MDRs.
d) The GNI **shall** monitor the functional status of its associated UHF radios.
e) The GNI **shall** support monitoring of the port status of its A/G Router(s).

3.4.3.3.2 GNI Subsystem Remote Control Functions

a) The GNI **shall** support remote control of its associated RIUs.
b) The GNI **shall** support remote control of its associated MDRs.
c) The GNI **shall** support remote control of its associated UHF radios.
d) The GNI **shall** coordinate operation of primary and backup site radio strings for a given User Group.

__Note__: This includes coordination of the data protocol states between the sites and Beaconing control.

3.4.3.4 GNI Subsystem Interfaces

3.4.3.4.1 GNI/Telecommunications Interfaces

a) The GNI **shall** interface with at least a 56 kbps digital service via a DDC interface to access the remote RIU.
b) The GNI **shall** support usage with analog 4-wire VG-6 ground telecommunications circuits to access the remote RIU, when the digital interface is not being used.
c) The GNI **shall** support usage with analog 4-wire VG-8 telecommunications circuits to access the remote RIU, when the digital interface is not being used.
d) The GNI **shall** support redundant telecommunications interfaces for each RIU per Section 3.2.3.8.1.e).

__Note__ 1: The telecommunications interfaces may be on dissimilar media.

e) When configured for standby telecommunications backup, the GNI **shall** detect transmission path failures (defined as an inability to communicate with an RIU for a 3 second period), switch to an alternate transmission path, and restore communications to the RIU.

__Note__ 2: This assumes the presence of an alternate telecommunications path to the RIU. It is recognized that not all sites have this redundancy.

f) When configured for hot telecommunications backup with an RIU, the GNI **shall** simultaneously communicate over the redundant telecommunications interfaces with that RIU.
g) When configured for hot telecommunications backup with an RIU, the GNI **shall** be able to use information from either interface without interfering with the operation of the communications system.
h) When configured for standby telecommunications backup with an RIU, the GNI **shall** communicate over at least one telecommunications interface with that RIU.

3.4.3.4.2 GNI/RIU Interfaces

a) The GNI **shall** interface with RIUs via the GNI/Telecommunications interface.

__Note__ 1: This includes the capability for Local Radios, where RIUs will be required.

b) The GNI **shall** be scalable in the number of RIUs that may be supported.
c) The GNI **shall** support a configuration with separate RIUs for transmitters and receivers.

Note 2: The separate RIUs are envisioned to be using different telecommunications interfaces, and the GNI will need to forward messages between the two RIUs.

3.4.3.4.3 GNI General Purpose Interfaces

a) The GNI **shall** provide at least 3 RS-232 data connections per RIU supported.

Note: These connections are for use in general messaging via the RIU.

b) The general data streams **shall** have a lower priority than voice, data, or MMC.

3.4.3.4.4 GNI Human Interfaces

a) The GNI **shall** indicate the operational voice activity of each voice circuit to the front panel.
b) The GNI **shall** indicate the status of each thread to the front panel.
c) The GNI **shall** be configurable only from the NEXCOM/NIMS interface and the MMCWS.

3.4.3.4.5 Power Interfaces

a) The GNI **shall** interface with existing critical power in NAS facilities consistent with FAA Order 6950.2D.
b) The GNI **shall** comply with requirements of the critical power bus.
c) The GNI **shall** continue to operate at least twenty minutes after the loss of critical power.

3.4.3.4.6 GNI/VSCE Interfaces

a) The GNI **shall** interface with existing VSCE (e.g., VSCS, ETVS, ICSS, RDVS, STVS) via existing interfaces (e.g., Single channel (V+U) and quad channel (V/U/M/S)).
b) The GNI **shall** interface with voice switches via a common digital interface.

Note: The intent is for this to be an interface common to all VSCE that will be defined in the ICD yet to be coordinated with the Voice Switching Group.

3.4.3.4.7 GNI/Router Interfaces

a) A GNI **shall** interface with an A/G Router via a GNI Data Switch function, per Appendix B.4.

Note 1: GNIs may share the data switch function to interface with the A/G Router.

b) A GNI **shall** interface with at least two different A/G Routers.

Note 2: GNIs may share the data switch function to interface with the A/G Router.

3.4.3.4.8 GNI/GNI Interfaces

a) The GNI Data Switch function **shall** merge data communication paths from GNIs to an A/G Router.
b) The GNI Data Switch function **shall** be used to interconnect GNIs.

Note 1: Not every GNI is required to implement this Data Switch function. This function may be implemented in a separate LRU.

c) GNIs from adjacent control facilities **shall** coordinate handoffs of Mobile User between these facilities.

Note 2: There are two types of Mobile User data handoffs: one that is GNI/GNI connected to the same A/G Router port and one which is between A/G Router ports.

d) The GNI **shall** support at least two paths for GNI interconnections.

Note 3: This requirement is intended to provide diverse connections from a GNI to diverse A/G Routers and the GNI interconnections. This may be implemented via redundant lines between GNIs or via connections to other GNIs to provide a diverse path.

3.4.3.4.9 GNI/Automation Interfaces

a) The GNI **shall** interface with the automation system to receive Next Channel Uplink information.
b) The GNI **shall** receive confirmation from the radio site as to the success of the uplink of the Next Channel Uplink information.
c) The GNI **shall** present to the automation system the confirmation signal on success of the Next Channel Uplink transmission.
d) The GNI **shall** provide indication to the automation system of the login status of the Mobile User.
e) The GNI **shall** provide indication to the automation system of the Talker ID (Mobile User identity) of the Mobile User communicating on the voice channel for VDL Mode 3.
f) The GNI **shall** provide indication to the automation system of received Urgent Downlink Requests for VDL Mode 3.

3.4.3.4.10 GNI/MMC Workstation Interface

a) Each GNI **shall** interface to the collocated MMCWS.

3.4.3.5 Signaling

a) The GNI **shall** pass the signaling indicated in Section 3.4.2.5 e) from the VSCE to the RIU.
b) The GNI **shall** pass the signaling from the RIU to the VSCE as indicated in Section 3.4.2.5 b), d), and g).

Note: The Automation interface may introduce additional signaling to support its functions.

3.4.3.6 GNI Reliability/Maintainability

a) The GNI **shall** support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.

Note: This applies to each string, or thread, associated with the GNI and RIU.

3.4.3.6.1 GNI Redundancy

a) The failure of any thread(s) within the GNI to its RIU **shall** not degrade communications of any other GNI/RIU threads.
b) A failure within a GNI **shall** not cause loss of communications within a User Group.
c) Failure of a single GNI thread **shall** not cause loss of A/G communications services.

3.4.4 A/G Router Functional Requirements

The A/G Routers within the NEXCOM System and the ATN regional backbones make up the ATN Router subsystems.

***Note**: The references to ICAO Document 9705 refer to Edition 3 or later.*

3.4.4.1 A/G Routing

a) The A/G Router **shall** implement air/ground routing protocols as per ICAO Document 9705.
b) Each A/G Router **shall** be located at an ARTCC.

***Note** 1: A/G Routers are being restricted to only ARTCCs facilities to reduce the capacity impact of IDRP connection changes through the narrow bandwidth of the A/G channel.*

c) Each A/G Router **shall** be responsible for providing the ATN subnetwork services to the GNI(s) within its domain.
d) The A/G Router **shall** conform to FAA routing policies.

***Note** 2: FAA routing policies define what applications are to use which subnetworks and how routing updates will be distributed. The details of this information will be contained in the derived SSS.*

3.4.4.1.1 A/G Router Subnetwork Services

The A/G Router provides and interfaces through the Subnetwork Dependent Convergence Function (SNDCF) to support VDL Mode 3 Packet Layer Protocol (PLP) Compression, Connectionless Network Protocol (CLNP) Frame Mode Compression, and ATN Frame Mode.

3.4.4.1.1.1 SNDCF for ISO/IEC 8208 Mobile Subnetworks

a) The A/G Router **shall** implement the SNDCF for ISO/IEC 8208 Mobile Subnetworks per ICAO Document 9705, as an interface to the VDL Mode 3 PLP Compressor.

3.4.4.1.1.2 SNDCF for Frame Mode Mobile Subnetworks

a) The A/G Router **shall** be upgradeable to implement the SNDCF for Frame Mode Mobile Subnetworks per ICAO Document 9705, as an interface to the ATN Frame Mode Compressor.

Note: The ATN SARPs refer to this as Frame Mode, while the VDL Mode 3 SARPs and MASPS refer to this as ATN Frame Mode.

3.4.4.1.1.3 SNDCF for VDL Mode 3 Frame Mode Mobile Subnetworks

a) The A/G Router **shall** implement the SNDCF for VDL Mode 3 Frame Mode Mobile Subnetworks per ICAO Document 9705, as an interface to the CLNP Frame Mode Compressor.

3.4.4.2 Maintenance, Monitoring and Control

3.4.4.2.1 Local MMC

a) The A/G Router **shall** provide local configuration, monitoring and control for the router.

3.4.4.2.2 Remote MMC

a) The A/G Router **shall** provide remote MMC access to NIMS.

3.4.4.3 A/G Router Reliability/Maintainability

a) The A/G Router subsystem **shall** provide at least two independent paths from the GNI to the ATN network.

Note: To meet a service availability of 0.99999 for critical service, there will need to be a second router path available to each GNI.

3.4.5 MDT Functional Requirements

a) The MDT **shall** provide a means for asserting the same operational functions normally available via the VSCE interface (e.g., Main, Standby, and BUEC transmitters and receivers selection, PTT, Mute, etc.) for each Talk Group(s) to which it is attached.
b) The MDT **shall** provide a means for monitoring the operational status of the User Group(s) to which it is attached.

3.4.5.1 Local MMC

a) The NEXCOM MDT function **shall** use an existing NAS MDT to access local maintenance, monitoring and control functions of the RIU, and MDR.

3.4.5.2 Remote MMC

a) When connected to an RIU, the NEXCOM MDT function **shall** access remote MMC information from all MDRs, and UHF radios that are attached to the RIU.

b) The NEXCOM MDT function **shall** access all RIUs at a facility from a common connection point.

Note: When connecting an MDT to an RIU, one can plug into a single unit at the remote site and perform MMC on all components at the site without having to reconnect with each individual component.

3.4.5.3 Logging

a) The MDT **shall** download and store the log files from the RIUs and MDRs at a site.

3.4.5.4 MDT Security

a) The MDT **shall** support the assignment of a unique logon identifier for each user.
b) When passwords are to be used for authentication, the MDT **shall** use strong passwords (e.g., prevent the use of dictionary words).
c) The MDT **shall** enforce mandatory password changes at set intervals.
d) The MDT **shall** prevent the reuse of passwords on a per user basis.
e) The RIU/MDT **shall** implement Strong Authentication.
f) The MDT **shall** enable access Authorization Management
g) The MDT **shall** enforce separation of duties through its role-based ability to restrict users to specific MMC functions and to specific actions on those functions.

Note 1: This requirement is based on privilege levels defined elsewhere in this document.

h) The MDT **shall** temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.
i) The MDT **shall** display a configurable banner page upon login.
j) The MDT **shall** protect NEXCOM information system security data from all unauthorized access.

Note 2: This may require encryption of log file and key material in addition to protecting security functions.

k) The MDT **shall** terminate control access to any subsystem after a configurable amount of control inactivity.

3.4.6 Workstation Functional Requirements

a) The MMCWS **shall** provide a means for asserting the same operational functions normally available via the VSCE interface (e.g., Main, Standby, and BUEC transmitters and receivers, PTT, Mute, etc.) for each Talk Group(s) to which it is attached.
b) The MMCWS **shall** provide a means for monitoring the operational status of the User Group(s) to which it is attached.

3.4.6.1 Local MMC

a) The MMCWS **shall** be a control access point for local maintenance, monitoring and control functions of the GNI.

3.4.6.2 Remote MMC

a) The MMCWS **shall** access remote MMC information from all connected RIUs.
b) The MMCWS **shall** access remote MMC information from all connected MDRs.
c) The MMCWS **shall** access remote MMC information from all connected UHF radios.
d) The MMCWS **shall** monitor all connected A/G Routers.

__Note__ 1: This would be via the NIMS connection to the GNI.

e) The MMCWS **shall** monitor MMC information from the Data Link Application End System responsible for the GNI with which the MMCWS is associated.

__Note__ 2: This is intended to be the ability to ping and trace route to the End System.
__Note__ 3: The above is expected to be available through the NIMS interface of the Data Link Application End System. This End System is part of the automation system (e.g., DLAP).

3.4.6.3 Logging

a) The MMCWS **shall** log all alerts and alarms from all NEXCOM Subsystems.
b) The MMCWS **shall** log all MMC control commands sent to the NEXCOM Subsystems, except the A/G Router.
c) The MMCWS **shall** log all access attempts to the MMC system.

3.4.6.4 Platform Requirements

a) The MMCWS **shall** reside on platforms compatible with those already in the NAS, to include MDT platforms.

__Note__: In case of catastrophic failure of the MMCWS, the MDT can function as the MMCWS. This also means that the interface between the GNI and MMCWS has to also exist on the MDT.

3.4.6.5 MMCWS Security

a) The MMCWS **shall** support the assignment of a unique logon identifier for each user.
b) The MMCWS **shall** authenticate the claimed user's identity before allowing the user to perform any actions other than a well-defined set of operations.
c) When passwords are to be used for authentication, the MMCWS **shall** use strong passwords (e.g., prevent the use of dictionary words).
d) The MMCWS **shall** enforce mandatory password changes at set intervals.
e) The MMCWS **shall** prevent the reuse of passwords for 6 months on a per user basis.
f) The MMCWS **shall** implement strong authentication.
g) The MMCWS **shall** enable access Authorization Management.
h) The MMCWS **shall** enforce separation of duties through its role-based ability to restrict users to specific MMC functions, and to specific actions on those functions.

Note: This requirement is based on privilege levels defined elsewhere in this document.

i) The MMCWS **shall** temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.
j) The MMCWS **shall** display a configurable banner page upon login.
k) The MMCWS **shall** protect information system security data and functionality from all unauthorized access.
l) The MMCWS **shall** terminate NEXCOM control access to any subsystem after a configurable amount of NEXCOM control inactivity.

3.4.7 Timing Source

3.4.7.1 Time Conditioning

a) The Timing Source **shall** synchronize timing with the Timing Reference.
b) The Timing Source **shall** provide timing to connected RIU(s).

3.4.7.2 Timing Source Interfaces

a) The Timing Source **shall** interface with the Timing Reference.
b) The Timing Source **shall** interface to collocated RIU(s).

3.4.7.3 Status Monitoring

a) The Timing Source **shall** monitor the status of the Timing Reference.
b) The Timing Source **shall** provide status information concerning the Timing Reference to the RIU.

3.5 Subsystem Performance Allocations

The following subsections provide the performance allocations for the NEXCOM Subsystems.

3.5.1 MDR Performance Allocations

The following performance requirements apply only to the MDR.

3.5.1.1 MDR Sustainment Operation

a) The NEXCOM MDR subsystems **shall** meet the performance requirements specified in the following:
   1) FAA-P-2883, Purchase Description, VHF/UHF Air/Ground Communications Receiver
   2) FAA-P-2884, Purchase Description, VHF/UHF Air/Ground Communications Transmitter

3.5.1.2 MDR Subsystem Functions

3.5.1.2.1 MDR Audio Processing Delay

Note: See Appendix F for further explanation regarding the audio delay.

3.5.1.2.2 Uplink Digital Voice Delay in MDR Transmitter

a) The uplink audio processing delay contribution of each MDR transmitter in digital voice modes **shall** be less than or equal to 6 ms, measured from the reception of the complete High-Level Data Link Control (HDLC) voice burst message containing vocoder frame 6 from the RIU to the time when the MDR begins RF transmission (referenced to the antenna port) of the first D8PSK symbol in vocoder frame 6.

3.5.1.2.3 Uplink Analog Voice Delay in MDR Transmitter

a) The uplink audio processing delay contribution of each MDR transmitter in analog voice modes via the RIU/MDR Digital interface (using PCM audio) to the RIU **shall** be less than or equal to 9 ms, measured from the reception of the second complete RIU HDLC PCM voice message to the time when the MDR begins RF transmission (referenced to the antenna port) of the first PCM voice message.
b) In sustainment mode, the audio processing delay in the MDR transmitter, measured from the analog voice input port on the MDR transmitter to the transmitter antenna port, with the Push-to-Talk (PTT) signal line activated at the RCE/MDR interface, **shall** be less than 13 ms.

3.5.1.2.4 Downlink Digital Voice Delay in MDR Receiver

a) The downlink audio processing delay contribution of the MDR receiver in digital voice modes **shall** be less than or equal to 17 ms, measured from the Time of Arrival of the last D8PSK symbol of the first vocoder frame in a VDL Mode 3 voice burst at the antenna port to the time when the MDR completes transmission of the HDLC voice burst message containing vocoder frame 1 to the RIU.

3.5.1.2.5 Downlink Analog Voice Delay in MDR Receiver

a) The downlink audio processing delay contribution of the MDR receiver in analog voice modes via the RIU/MDR Digital interface (using PCM audio) to the RIU **shall** be less than or equal to 83 ms, measured from MDR receiver squelch break to the time when the MDR receiver completes transmission of the second HDLC PCM voice message to the RIU.
b) In sustainment mode, the audio processing delay in the MDR receiver, measured from the RF signal received at the MDR receiver antenna port to the corresponding demodulated analog voice output of the receiver, **shall** be less than 13 ms.

   Note*: This delay is due to the need to allow two frames of buffering to prevent underflow with the largest allowable PCM frame size of 25 ms. Further explanation is contained in Appendix F.*

3.5.1.3 RESERVED

3.5.1.4 RESERVED

3.5.1.5 MDR System Timing

a) The time offsets for transmission arrival for VDL Mode 3 voice, data or management burst messages **shall** not deviate by more than ±10 μs from the MDR's timing reference point.
b) The time offsets for the reception window for VDL Mode 3 voice, data or management burst messages **shall** be accurate to ±10 μs from the RIU's system time.

Note: This implies that the time offset for transmission and subsequent reception arrival can be up to 20 μs from the system timing reference.

3.5.1.6 MDR Reliability/Maintainability

a) The MDR transmitter and the MDR receiver **shall** have a combined MTBF equal to or greater than 26,280 operational hours.

Note: For MTBF calculations, the MDR is defined as a MDR transmitter and a MDR receiver, as identified in Table E-1.

3.5.2 RIU Performance Allocations

The following performance requirements apply only to the RIU.

3.5.2.1 RESERVED

3.5.2.2 RIU Subsystem Communication Performance

3.5.2.2.1 Air/Ground Voice and Data

3.5.2.2.1.1 RESERVED

3.5.2.2.1.2 RIU Subsystem Data Operation

3.5.2.2.1.2.1 RIU/GNI Message Delays

a) The RIU **shall** complete the transmission of a valid DLS frame over the RIU/GNI telecommunications link no later than 500 ms after the last data burst message associated with the DLS frame is received from the MDR Receiver.
b) The RIU **shall** provide timing signals to the GNI to minimize end-end voice delay.

3.5.2.3 RESERVED

3.5.2.4 RIU Subsystem Interface

3.5.2.4.1 RIU/Telecommunications Interfaces

3.5.2.4.1.1 Transmission Path Failure Restoration

a) For telecommunications service failures where a redundant path exists and the NEXCOM System is configured for standby telecommunications backup, the RIU **shall** restore communications to the GNI via the alternate path within 1 second.
b) For telecommunications service interruptions of less than 1 second in duration, the RIU **shall** restore communications to the GNI within 120 ms.
c) For telecommunications service failures of greater than 1 second in duration where no redundant path exists, the RIU **shall** establish the connection for operational use within 3 seconds.
d) The RIU, when so configured, **shall** complete the switch back to the primary telecommunications link within 3 seconds after receiving the GNI switching command and PTT deactivation, without loss of data.

3.5.2.4.2 RESERVED

3.5.2.4.3 General Data Interfaces

a) The RIU **shall** interface at up to 9,600 bps on each of the general data interfaces.
b) The RIU **shall** provide an aggregate rate of at least 1,200 bps for all of the general data interfaces.

Note: The current RCE provides 880 bps total aggregate rate.

3.5.2.5 RIU Signaling

3.5.2.5.1 RIU Signaling Integrity

a) The RIU **shall** ensure that no more than one control signal in one million is falsely interpreted or not completed.

3.5.3.5.2 RIU Signaling Delay

Note: Additional signaling delays shared between the GNI and RIU can be found in section 3.5.3.5.2. Specific allocation of delays between the GNI and RIU are implementation issues for a lower level specification.

3.5.2.6 RIU Reliability/Maintainability

a) The RIU MTBF **shall** be equal to or greater than 40,000 operational hours.

3.5.2 7 RIU Site Configuration

a) The RIU **shall** be located within 6,000 feet of the MDR transmitter to ensure proper timing of the MDR transmissions.

Note: There might be means to extend the distance beyond this limit, but it is the responsibility of the implementer to verify requirements can be achieved.

3.5.3 GNI Performance Allocations

The following performance requirements apply only to the GNI subsystems.

3.5.3.1 GNI Subsystem Performance

3.5.3.2 GNI Subsystem Communication Performance

3.5.3.2.1 Air/Ground Voice and Data

3.5.3.2.1.1 RESERVED

3.5.3.2.1.2 GNI Subsystem Data Operation

3.5.3.2.1.2.1 GNI Data Processing Delay

a) The processing delay for multiplexing VDL Mode 3 voice and data of a GNI subsystem **shall** be less than 10 ms.
b) MMC data processing **shall** not delay uplink or downlink voice and control data processing or distribution.

3.5.3.2.1.2.2 GNI Connectivity Report Time

a) The GNI **shall** comply with connectivity reporting time requirements of ATSC Class B service identified in Table 3-1.

3.5.3.3 RESERVED

3.5.3.4 GNI Subsystem Interfaces

3.5.3.4.1 GNI/Telecommunications Interface

3.5.3.4.1.1 Transmission Path Failure Restoration

a) For telecommunication service failures where a redundant path exists and the NEXCOM System is configured for standby telecommunications backup, the GNI **shall** restore communications to the RIU via the alternate path within 1 second.
b) For telecommunications service interruptions of less than 1 second in duration, the GNI **shall** restore communications to the RIU within 120 ms.

c) For telecommunications service failures of greater than 1 second in duration where no redundant path exists, the GNI **shall** establish the connection for operational use within 3 seconds..
d) The GNI **shall** complete the switch back to the primary telecommunications link in less than 3 seconds with no loss of data, after the primary link is restored and PTT is deactivated.

3.5.3.4.2 GNI/RIU Interface

a) The GNI **shall** support a control facility that interfaces to at least 350 RIUs.

   ***Note** 1: Many control facilities will have significantly less than 350 RIUs connected. Therefore, a scalable GNI is specified in Section 3.4.3.4.2.*
   ***Note** 2: This assumes a worst-case implementation without bundling multiple voice channels on an RIU. Bundling may reduce the number of RIUs that need to be supported depending on the System Configuration being used (e.g., up to 4 voice channels on an RIU for 4V).*
   ***Note** 3: This requirement needs to be implemented in such a way that there is no single point of failure.*

3.5.3.4.3 General Data Interface

a) The GNI **shall** interface at up to 9,600 bps on each of the general data interfaces of Section 3.4.3.4.3.
b) The GNI **shall** provide an aggregate data rate of at least 1200 bps for all of the general data lines.

   ***Note**: Section a) indicates the interface speed, while b) specifies the actual communication bandwidth that can transfer general data across the lines between the GNI and RIU.*

3.5.3.5 Signaling

3.5.3.5.1 GNI Signaling Integrity

a) The GNI **shall** ensure that no more than one control signal in one million is falsely interpreted or not completed.

3.5.3.5.2 GNI/RIU Signaling Delay

All of the following event response times are performed without telecommunications delays between the RIU and the GNI for both VHF and UHF signals, as appropriate.

3.5.3.5.2.1 PTT/PTT Release

a) Based on VSCE PTT signaling, the RIU **shall** provide the PTT signal at the RIU/Analog Radio interface from 15 - 25 ms prior to the audio for 99.9% of the events.
b) The response time from the instant the GNI receives a PTT/PTT Release signal from the VSCE, to the instant the RIU provides/removes PCM voice packets at the RIU/MDR interface **shall** not exceed 208 ms for 99.9% of the events.

c) The response time from the instant the GNI receives a PTT/PTT Release signal from the VSCE, to the instant the RIU provides/removes VDL Mode 3 voice packets at the RIU/MDR interface **shall** not exceed 165 ms for 99.9% of the events.

3.5.3.5.2.2 PTT/PTT Release Confirmation

a) The response time from the instant the RIU provides/removes the PTT/PTT Release signal at the RIU/Analog Radio interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.
b) The response time from the instant the RIU provides/removes the PCM voice bursts at the RIU/MDR interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.
c) The response time from the instant the RIU provides/removes the VDL Mode 3 voice bursts at the RIU/MDR interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.

3.5.3.5.2.3 Preemption of Mobile Users' Voice Transmissions

a) The Voice Preemption signal **shall** be contained in the next scheduled uplink Beacon that occurs at least 50 ms after the reception of the Voice Preemption and PTT signals from the NEXCOM/VSCE interface for 99.9% of the preemption events.

3.5.3.5.2.4 Preemption Confirmation of Mobile Users' Voice Transmission

a) The response time from the instant the Voice Preemption signal is generated at the RIU to the instant when the Voice Preemption Confirmation signal is received at the NEXCOM/VSCE interface **shall** not exceed 340ms for 99.9% of the events.

3.5.3.5.2.5 Squelch Break

a) The response time from the instant the Analog Radio provides/removes the Squelch Break signal at the RIU/Analog Radio interface, to the instant that the Squelch Break signal appears at the NEXCOM/VSCE interface **shall** not exceed 100 ms for 99.9% of the events.
b) The response time from the instant the MDR provides/removes voice bursts at the RIU/MDR interface, to the instant that the GNI provides an Squelch Break indication at the NEXCOM/VSCE interface **shall** not exceed 100 ms for 99.9% of the events.

3.5.3.5.2.6 Received Audio Muting

3.5.3.5.2.6.1 RESERVED

3.5.3.5.2.6.2 RESERVED

3.5.3.5.2.6.3 Commanded Mute/Unmute Confirmation

a) The response time from the instant the voice signal is muted/unmuted in the RIU to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.
b) The response time from the instant the Commanded Mute/Unmute signal is available at the RIU/Analog Radio interface to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.
c) The response time from the instant the Commanded Mute/Unmute signal is available at the RIU/MDR interface to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 340 ms for 99.9% of the events.

3.5.3.5.2.7 Ground Radio Resource Selection and Switching

3.5.3.5.2.7.1 Ground Radio Resource Selection

a) The response time from the instant the VSCE provides Ground Radio Resource Selection (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary) signal at the NEXCOM/VSCE interface, to the instant RIU executes the actions **shall** not exceed 100 ms for 99.9% of the events.

3.5.3.5.2.7.2 Ground Radio Resource Selection Confirmation

a) The response time from the instant the RIU completes Ground Radio Resource Selection actions (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary), to the instant the GNI provides a Ground Radio Resource Selection Confirmation signal at the NEXCOM/VSCE interface **shall** not exceed 250 ms for 99.9% of the events.

3.5.3.5.2.8 Dual Control VHF/UHF Lockout/Lockout Release

a) The response time from the instant the VHF/UHF Lockout/Lockout Release condition is declared in the RIU to the instant when the GNI is notified of the VHF/UHF Lockout/lockout release condition **shall** not exceed 120ms for 99.9% of the events.

3.5.3.6 GNI Reliability/Maintainability

a) The GNI MTBF **shall** be equal to or greater than 30,000 operational hours.

   ***Note** 1: While 10,000 hours would achieve the 0.99999 level of service availability with a redundant backup, the MTBF is increased to reduce the number of maintenance actions to around 1 per 2 years.*
   ***Note** 2: This is based on the string, or thread, associated with the GNI and RIU.*

3.5.4 A/G Router Performance Allocations

The following performance requirements apply only to the A/G Router subsystems.

3.5.4.1 Air/Ground Routing

3.5.4.1.1 A/G Router Capacity

a) Each A/G Router **shall** support at least 1000 Mobile Users.

3.5.4.1.2 A/G Router Traffic Loading

a) The A/G Router **shall** process at least 1500 join events per hour.
b) The A/G Router **shall** process at least 1500 leave events per hour.
c) The A/G Router **shall** process at least 55 Network Protocol Data Units (NPDU) per second, each of 256 octets in length.

Note: The above performance requirements assume the use of Regional Backbone routers to limit the distribution of route updates within the ATN network.

3.5.4.2 RESERVED

3.5.4.3 A/G Router Reliability/Maintainability

a) The A/G Router MTBF **shall** be equal to or greater than 19,996 operational hours.

Note: To meet a service availability of 0.99999 for critical service, there will need to be a second router path available to each GNI.

3.5.5 MDT Performance Allocations

RESERVED

3.5.6 MMCWS Performance Allocations

3.5.6.1 MMCWS MTBF

a) The MMCWS MTBF **shall** be equal to or greater than 9,000 operational hours.

3.5.7 Timing Source

3.5.7.1 RESERVED

3.5.7.2 Time Drift

a) With the loss of the external Timing Reference conditioning, the Timing Source **shall** maintain system timing for at least 30 days without degrading system operation due to timing.

Note: See Attachment G for further details of this timing.

3.5.7.3 Time Standard

a) The Timing Source **shall** be aligned with UTC on 6 January 1980.

Note: The above requirement implies that leap seconds are not compensated for, as leap second adjustments would perturb the operation of the system. GPS is one system that is aligned with UTC on 6 January 1980. Any other absolute time source which is traceable to UTC without leap second adjustments is also suitable as an external Timing Reference for VDL Mode 3.

3.6 External Functional Allocations

The NEXCOM System is integrated with, and dependent on other elements of the NAS. Some of the NEXCOM's functionality depends on interfaces with and/or enhancements of other NAS elements. The NEXCOM program will jointly develop IRDs for such interfaces. Functions allocated external to the NEXCOM equipment are described in the following subsections.

3.6.1 Voice Switch Functional Requirements

NEXCOM will add new features and capabilities for AT controllers. NEXCOM has functional interfaces to VSCE equipment. In order to make the new capabilities and features available the VSCE and controller interface will require modifications.

3.6.1.1 Voice Switches Affected

The following is a representative list of voice switches that will need to change to implement NEXCOM features and new capabilities:
a) VSCS
b) ETVS
c) RDVS
d) STVS
e) AFSSVS

3.6.1.2 Voice Switch Function Affected

The changes described here are NEXCOM VDL Mode 3 capabilities.

3.6.1.2.1 PTT/PTT Release Confirmation

This requirement is intended to give the controller a continual awareness of the status of the channel activation as it is extended out of the VSCE to the MDR transmitter and confirmed back to the VSCE.
a) The VSCE **shall** continually indicate to the controller transmit channel status via PTT confirmation.

Note: If any receiver has the ability to receive the NEXCOM controlled transmitter's RF emanations and to generate a Squelch Break signal back, then the controller can gain a more accurate depiction of whether or not the transmitter is actually transmitting.

3.6.1.2.2 Preemption of Mobile Users' Voice Transmissions

The feature allows the AT controller to assert priority over voice communications regardless of the channel status. It is also referred to as controller override.

a) The VSCE controller interface **shall** generate a Voice Preemption signal, which in the presence of a PTT serves to terminate all PTT voice transmission within a Talk Group.
b) The VSCE **shall** deliver the preemption signal to the NEXCOM System interface.

***Note** 1: This gives the controller the capability to un-key a stuck microphone of a member of the Talk Group.*
***Note** 2: For activation of the preemption, the Voice Preemption signal needs to be present in conjunction with a PTT from the VSCE.*

3.6.1.2.3 Preemption Confirmation of Mobile Users' Voice Transmissions

a) The VSCE **shall** indicate to the controller the Voice Preemption Confirmation signal generated by the NEXCOM System.

3.6.1.2.4 Squelch Break

a) The VSCE **shall** continually indicate to the controller Squelch Break status.

3.6.1.2.5 Ground Radio Resource Selection Confirmation

This capability is provided in NEXCOM to indicate to the user the operational status of the link. This is intended to allow the controller to know on which radio he or she is actively transmitting.

a) The VSCE **shall** indicate to each controller the actual configuration of the equipment supporting that controller's Talk Group based on feedback from the NEXCOM System.

***Note**: The NEXCOM system will indicate to the VSCE by a signal from the transmit/receive site which transmitter and receiver is active. The VSCE indicates to the controller which equipment is selected*

3.6.1.2.6 Channel Busy Signal

The channel status feature indicates to a user that the channel access or request has been denied. It is akin to a "channel busy" signal. The users only see their own channel denial, not the denials of the channel to other users.

a) The VSCE **shall** provide an indication to the controller that the requested channel is occupied.

***Note**: The channel busy signal indicates to a controller that the channel is occupied by a mobile user transmission.*

3.6.1.2.7 Channel Labeling

This requirement provides capability for the VSCE to select A/G channels that are added as a result of introducing NEXCOM.

a) The VSCE A/G channel selector **shall** display six numerical characters in accordance with ICAO Annex 10, Vol. V, Ch. 4.

Note: The VSCE needs to support channel labeling for all NEXCOM modes, i.e., VDL Mode 3, DSB-AM 25kHz, and DSB-AM 8.33 kHz.

3.6.2 Telecommunications Functional Requirements

3.6.2.1 Support for Voice, Data and Signaling

a) Telecommunications links **shall** support voice, data and signaling for the NEXCOM System.

3.6.2.2 Telecommunications Interfaces

a) Telecommunications circuits **shall** interface via either 4-wire or DDC, as needed.

Note: See Section 3.2.3.8.1 in SRD.

3.6.2.3 Physical Path Diversity

a) Telecommunications link(s) **shall** provide at least one telecommunications circuit between an RIU and its associated GNI.
b) Telecommunications link(s) **shall** provide diversity between telecommunications circuits for connectivity for selected A/G Communications sites in accordance with FAA Order 6000.36A.

Note: This requirement varies on a site-by-site basis. AF regional administrators decide the BUEC site connectivity requirement. While Circuit diversity Order 6000.36A defines the separation between radio circuits, LINCS and FTI services provide this type of separation as "Avoidance" in various types, depending upon the capability of Telecommunications Infrastructure (that is Service Providers and/or Government resources).

3.6.2.4 Telecommunications Availability

a) Telecommunications **shall** support A/G voice and data service.

3.6.3 NAS Infrastructure Management System (NIMS) Functional Requirements

a) The NIMS **shall** interface with the NEXCOM System via an interface compliant with FAA-E-2911 and the NEXCOM/NIMS Interface Control Document (ICD), NAS-IC-TBD.
b) The NIMS **shall** provide a Computer Human Interface (CHI) for the Remote Maintenance Monitor functions of the NEXCOM System.
c) The NIMS **shall** assign for each NIMS user authorized to access the NEXCOM MMC a pre-defined privilege level to the NEXCOM/NIMS interface.
d) The NIMS **shall** provide mapping from the NIMS users to their associated privilege levels.

Note: The privilege level information will be used by the GNI to determine the specific MMC functions available to users with that privilege level.

3.6.3.1 NIMS/NEXCOM Interface

a) The NIMS interface to the NEXCOM System **shall** be located at the GNI.

3.6.3.1.1 Status Monitoring

a) The NIMS **shall** provide status monitoring of the NEXCOM (Sub)system(s), when authorized.

3.6.3.1.2 Control

a) The NIMS **shall** control the NEXCOM (Sub)system(s), when authorized.

3.6.3.1.3 Performance Monitoring

a) The NIMS **shall** provide performance monitoring of the NEXCOM (Sub)system(s).

3.6.3.1.4 Fault Isolation

a) The NIMS **shall** access the fault isolation data capabilities of the NEXCOM (Sub)system(s).

3.6.3.1.5 Service/Equipment Certification

a) The NIMS **shall** provide access to those functions that are provided by the NEXCOM System for Service/Equipment Certification.

3.6.3.1.6 Digital Link Integrity

a) The NIMS **shall** provide monitoring status of the Digital Link Integrity provided by the NEXCOM System.

3.6.3.1.7 UHF Interface

a) The NEXCOM System **shall** collect, transport, and provide to the NIMS interface the MMC functionality of the UHF radios collocated with NEXCOM MDRs in accordance with the NEXCOM/NIMS ICD UHF radio subsections.

3.6.3.2 NIMS Security

The following requirements are based on NAS Information System Security (ISS) Architecture and NAS ISS Requirements documents. This minimum set of requirements allows for a trusted environment, which enables the exchange of information between the NIMS and the NEXCOM System.

a) The NIMS **shall** support the assignment of a unique logon identifier for each user.
b) The NIMS **shall** authenticate the claimed user's identity before allowing the user to perform any actions other than a well-defined set of operations.
c) When passwords are to be used for authentication, the NIMS **shall** use strong passwords (e.g., prevent the use of dictionary words).
d) The NIMS **shall** enforce mandatory password changes at set intervals.
e) The NIMS **shall** prevent the reuse of passwords on a per user basis.
f) The NIMS **shall** implement strong authentication.
g) The NIMS **shall** enable access Authorization Management.
h) The NIMS **shall** temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.

i) The NIMS **shall** protect NEXCOM information system security data and functionality from all unauthorized access.
j) The NIMS **shall** terminate NEXCOM control access to any subsystem after a configurable amount of NEXCOM control access inactivity.
k) The NIMS **shall** assure the integrity of all NIMS information being sent to NEXCOM.

3.6.4 Automation Functional Requirements

NEXCOM interfaces with the automation system via the GNI and the control site operations LAN. NEXCOM data capabilities will require modification of the automation system.

3.6.4.1 Automation Subsystems Affected

The following is a representative list of automation systems affected by NEXCOM features and capabilities:
a) CPDLC
b) Automated Radar Terminal System (ARTS)
c) Display System Replacement (DSR)
d) Host Interface Device (HID)
e) Standard Terminal Automated Replacement System (STARS)

3.6.4.2 Automation Functions Affected

The NEXCOM capabilities relate primarily to VDL Mode 3.

3.6.4.2.1 Next Channel Uplink Information

The next channel uplink information is sent from the ground to the aircraft control head for setting the aircraft's radio to the channel on which it will communicate with the next AT controller on its flight route.
a) The automation system **shall** have the capability to provide the next radio channel setting information to the NEXCOM System.

Note 1: *The capability will be needed for both datalink equipped Mobile Users and non-datalink equipped Mobile Users.*

b) Next Channel Uplink information **shall** be recorded.

Note 2: *This recording requirement is to support NTSB requirements to record communication between the controller and pilots.*

3.6.4.2.2 Urgent Downlink Request

The urgent downlink request feature allows a Mobile User in the Talk Group to indicate to the controller the need for downlink communications requiring high priority attention.
a) The automation system **shall** receive urgent downlink requests from the NEXCOM System and display to the controller.

3.6.4.2.3 Mobile User Logged In Feature

The Mobile User logged in feature notifies the controller that a Mobile User is a participant in the Talk Group. This feature allows for the display of the identity of the Mobile User to the controller for all of the sector's logged in Mobile Users. If the Mobile User identity is not displayed, the Mobile User has not logged into the net. Although the Mobile User has not logged in, the user still can access the voice channel and the sector's controller is aware of its presence due to other means (e.g., radar information, controller to controller coordination, and/or verbal communications from the pilot).

a) The automation system **shall** provide the capability of displaying to the operator all logged in members of a Talk Group based on input from the NEXCOM System.

3.6.4.2.4 Talker ID Feature

The Talker ID feature indicates which Mobile User is talking on the voice channel.

a) The automation system **shall** indicate to the controller's display which Mobile User is talking on the voice channel based on input from the NEXCOM System.

3.6.4.2.5 Data Interface

a) The CPDLC automation system **shall** interface the NEXCOM A/G Router to the ATN network.

3.6.4.3 Security Management

a) Automation **shall** implement a Public Key Infrastructure (PKI).

   Note*: This is not necessarily an assignment to any of the identified programs in section 3.6.4.1. It may require the FAA to establish a new program to support this capability.*

b) Automation's PKI **shall** support and maintain the key management of NEXCOM Subsystems.

3.7 External Performance Allocations

The External Functional Requirements addressed in Section 3.6 have performance implications associated that are outlined in the following subsections.

3.7.1 Voice Switch Performance

In this section the performance requirements of VSCE equipment interfacing with NEXCOM are specified. The corresponding NEXCOM System performance allocations are given in Section 3.3.3.6. These requirements do not take into account telecommunications delay.

3.7.1.1 RESERVED

3.7.1.2 Voice Switch Performance Affected

3.7.1.2.1 PTT/PTT Release Confirmation

a) The response time for the VSCE indication to the controller of PTT/PTT Release Confirmation, from the instant the GNI provides/removes the PTT /PTT Release Confirmation signal at the VSCE/GNI interface, **shall** not exceed 200 ms for 99.9% of the events.

***Note**: This requirement is in line with performance specifications for indicator signals in existing VSCE equipment (i.e., receiver muting confirmation or M/S TX/RX transfer confirmation).*

3.7.1.2.2 Preemption of Mobile Users' Voice Transmissions

a) The VSCE **shall** deliver the Voice Preemption signal within 50 ms of activation by a Mobile User for 99.9% of the events.

3.7.1.2.3 Preemption Confirmation of Mobile Users' Voice Transmission

a) The response time for the VSCE indication to the controller of Voice Preemption Confirmation, from the instant the GNI provides/removes the Voice Preemption Confirmation signal at the VSCE/GNI interface, **shall** not exceed 200 ms for 99.9% of the events. .

***Note**: This requirement for the Preemption signal performance needs to be consistent with PTT/PTT Release Confirmation performance.*

3.7.1.2.4 Squelch Break

a) The response time for the VSCE indication to the controller of Squelch Break, from the instant the GNI provides/removes the Squelch Break signal at the VSCE/GNI interface, **shall** not exceed 150 ms for 99.9% of the events.

***Note** : This requirement is in line with performance specifications for indicator signals in existing VSCE equipment (e.g., receiver muting confirmation or M/S TX/RX transfer confirmation).*

3.7.1.2.5 Ground Radio Resource Selection Confirmation

a) The response time for the VSCE indication to the controller of Ground Radio Resource Selection Confirmation, from the instant the GNI provides/removes the Ground Radio Resource Selection Confirmation signal (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary) at the VSCE/GNI interface **shall** not exceed 150 ms for 99.9% of the events.

***Note**: This requirement is in line with performance specifications for indicator signals in existing VSCE equipment (e.g., receiver muting confirmation or M/S TX/RX transfer confirmation).*

3.7.1.2.6 Channel Busy Signal

a) The response time for the VSCE indication to the controller of Channel Busy, from the instant the GNI provides/removes the Channel Busy signal at the VSCE/GNI interface, **shall** not exceed 150 ms for 99.9% of the events.

Note*: This requirement is in line with performance specifications for indicator signals in existing VSCE equipment (e.g., receiver muting confirmation or M/S TX/RX transfer confirmation).*

3.7.2 Telecommunications Performance Requirements

3.7.2.1 Support for Voice, Data and Signaling

3.7.2.1.1 Telecommunications Latency

a) One-way transfer delay contribution from terrestrial telecommunications alone **shall** not exceed 25 ms.

3.7.2.1.2 Line Characteristics

a) Analog telecommunications **shall** meet the performance requirements as specified in Telcordia TR-NWT-000335 based on FAA order 6000.22A.
b) Digital telecommunications **shall** meet the performance requirements as specified in Telcordia GR-499-CORE based on FAA order 6000.47.
c) Digital telecommunications connectivity **shall** provide a minimum of 99.9 percent error-free seconds for any 24-hour period.

Note*: An error free second is a second in which no bit errors are received.*

3.7.2.2 RESERVED

3.7.2.3 RESERVED

3.7.2.4 Telecommunications Availability

a) Telecommunications paths **shall** provide an availability of at least 0.9979.

Note *1: FAA Order 6000.36 on Communications Diversity requires all defined services in Appendix 1 of the Order, including all A/G telecommunications for all operational environments, be provided diversity utilizing service and/or circuit diversity.*
Note *2: Any exceptions to FAA Order 6000.36 must be jointly approved by the regional Airway Facilities and Air Traffic division managers and forwarded to the national oversight committee.*

3.7.3 NIMS Performance Requirements

a) The NIMS **shall** support NEXCOM System MMC performance characteristics in accordance with FAA-E-2911, Section 3.2.3 a).
b) The NIMS **shall** not interfere with the operational performance of the NEXCOM System.
c) The NIMS **shall** accommodate low data (high latency) rates.

3.7.4 Automation Performance Requirements

TBD

4.0 VERIFICATION

4.1 Critical Operational Issues

The following is the list of Critical Operational Issues:

a) Does NEXCOM interface and operate with existing equipment and systems?
b) Can NEXCOM be used without disruption or degradation to ATC operations?
c) Does NEXCOM provide the required level of reliability, maintainability and availability?
d) Can NEXCOM be maintained without disruption or degradation of current ATC operations?
e) Can NEXCOM (maintain at least) provide the current level of efficiency and accuracy of communications between the controller and pilot?
f) Does NEXCOM voice quality afford the required performance for effective exchange of controller and pilot communications?
g) Is AT and Airway Facilities (AF) training sufficient to allow AT to effectively operate the system and AF to effectively maintain the system?
h) Do NEXCOM National Airspace Integrated Logistics Support (NAILS) elements provide for effective operation, maintenance and support when deployed in the NAS?
i) Does the NEXCOM Remote Maintenance Monitoring System (RMMS) allow the technician to perform monitor and control activities from a remote location?

4.2 Test and Evaluation Requirements

Test and Evaluation (T&E) will be conducted by the FAA in accordance with Acquisition Reform Interim Guidance (ARIG) 96-1 and Acquisition Management System (AMS) Test & Evaluation (T&E) Process Guidelines, to test and evaluate system operational effectiveness and suitability including compatibility, interoperability, degraded operations, maintainability and supportability. T&E also identifies deficiencies in NAS hardware, software, security, human performance factors, critical operational issues (COIs) and/or operational concepts. Relational steps of systematic testing may include many of the following:

a) Research and Development (R&D) Prototype Testing;
b) Developmental Testing (DT);
c) Operational Capability Demonstration (OCD) and/or Operational Capability Testing (OCT) for COTS/NDI acquisitions;
d) First Article Test or Factory Acceptance Test (FAT);
e) Operational Test (OT); Production Acceptance Test (PAT);
f) Site Acceptance Testing (SAT);
g) Field Familiarization (conducted by Airway Facilities (AF) and Air Traffic (AT)).

The system will be subject to independent penetration testing. Additionally, the NEXCOM System has been identified for Independent Operational Test and Evaluation (IOT&E) which is conducted by the Office of Independent Operational Test and Evaluation (ATQ). Upon completion of OT, the IPT will notify ATQ via an Independent Operational Test and Evaluation Readiness Declaration (IOTRD) to conduct IOT&E. After OT and/or IOT&E and completion of Field Familiarization, the system will enter the in-service decision (ISD) for the go ahead to achieve Initial Operational Capability (IOC) and then Operation Suitability Demonstration

(OSD). The successful completion of OSD signifies the Operational Readiness Date (ORD) and acceptance of the new system.

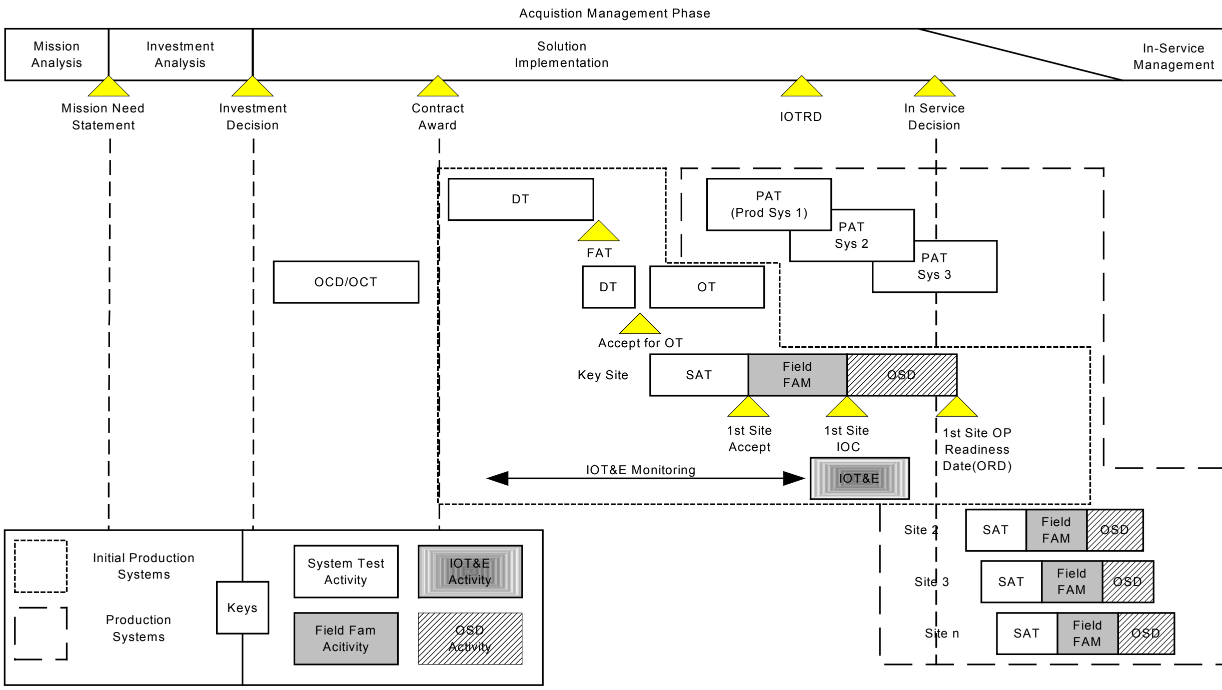


Figure 4-1

Tests and Test Activities

4.2.1 System Test

The NEXCOM Integrated Product Team (IPT) will lead the NEXCOM System test to verify contractual operational requirements and COIs. The following provides a synopsis of the test activities of System Test. Upon completion of OT, the IPT will issue the IOTRD to begin IOT&E

4.2.1.1 Developmental Test

The objective of Developmental Test (DT) will be to verify that all technical and performance requirements specified in the developmental portion of the contract have been met. DT normally will be performed by the contractor and witnessed by the product team at the factory and/or the William J. Hughes Technical Center (WJHTC). DT will begin with a series of hardware and software tests. Hardware tests will be at the Lowest Replaceable Unit (LRU) level and proceed to the (sub)system level. The tests will verify achievement of requirements relating to such factors as timing, RF performance, thermal stress, and electromagnetic interference. Software testing will verify the most detailed requirements at the unit level and proceed to verify higher-level integrated requirements at the segment level and, finally, to verify requirements at the computer software configuration item (CSCI) level. Developmental testing at the vendor's facility will conclude with a design qualification test that demonstrates the system's ability to satisfy the (sub)system specification(s).

Factory acceptance will be contingent on successful completion of the design qualification tests. If necessary, DT may be continued at the WJHTC in an environment that more closely replicates the actual field environment, i.e., real versus simulated interfaces. DT will verify that the system meets contract requirements. Entrance criteria include baselined requirements, a completed and approved Contractor Master Test Plan (CMTP), and approved test procedures. DT exit criteria or successful completion of DT testing requires that:

a) All test scripts have been executed and program trouble reports (PTRs) have been generated for each failure.
b) All PTRs have been resolved, i.e., PTRs have been fixed or deferred to a later release with government approval.
c) All changes made as a result of PTRs have been tested.
d) The test report has been reviewed and approved.
e) All documentation associated with the systems has been updated to reflect changes made during testing.

Acceptance of the system is contingent on successful completion of DT.

Factory Acceptance Tests (FATs) will verify that the NEXCOM System meets all requirements, such as but not limited to the applicable sections of Titles 29 & 40 of the CFR, and other applicable orders and directives. The vendor for each NEXCOM Subsystem will be responsible for performing the FAA witnessed FATs.

4.2.1.2 Operational Test

The Operational Test (OT) will be conducted at the WJHTC for the NEXCOM System and each subsystem. The OT will consist of integration tests, suitability tests and effectiveness tests. These tests will ensure that operational requirements have been met and that all Critical Operational Issues (COIs) have been resolved.

OT integration testing will verify that the system interfaces to the existing elements of the NAS and that the NAS can operate with the new (sub)system. Interface testing with future NAS elements may be provided through the use of simulators where warranted.

OT suitability testing will evaluate the degree to which the (sub)system intended for field use satisfies its availability, compatibility, transportability, interoperability, reliability, maintainability, safety, human factors, logistics supportability, documentation, FAA maintenance handbook and certification criteria, personnel, and training requirements. OT suitability testing also includes an assessment of the COIs.

OT effectiveness testing will evaluate the degree to which the (sub)system accomplishes its mission when used by representative personnel in the expected operational environment. This testing will include capacity and NAS loading, degraded mode operations, safety, security, and transition switchover. Key site personnel will operate the equipment for some of these tests, because they are the "most representative" operators, and so they can become familiar with the system. This approach will reduce the learning curve and minimize disruption when the (sub)system is installed at the key site. Effectiveness and suitability testing and evaluation may be continued at the key site(s) if a complete assessment cannot be accomplished at WJHTC. OT effectiveness testing will also assess COIs.

Entrance criteria for OT include successful completion of DT/FAT; baselined, configuration-managed technical documentation, software, and hardware; and completion of user training. After the successful conclusion of OT, the IPT will declare the system ready for IOT&E via the IOT&E Readiness Declaration (IOTRD) (for those programs designated for IOT&E). The IOTRD will address the IOT&E prerequisites/ requirements as detailed in the T&E section of the ASP.

4.2.1.3 Production Acceptance Test (PAT)

The FAA witnessed PAT (a subset of the DT/FAT) will be conducted to verify that the assembly line is producing units that have the same quality and performance as the DT/FAT.

4.2.1.4 Site Acceptance Test (SAT)

The FAA will conduct installation and check-out (INCO) and SAT. These tests will ensure that the system is installed and functioning properly.

4.2.1.5 Field Familiarization

Field familiarization will be conducted by AT and AF field personnel at each new site to which the new (sub)system is delivered. Field familiarization will be performed as the last part of System Testing , and the primary objective will be to verify that the site is ready to transition to the new (sub)system. This verification will include: ensuring that the new (sub)system has been properly installed and interfaced to the existing NAS; that operational procedures and system documentation are in place; that proper logistics and support are available; and that site personnel are adequately trained and ready to use the new system. Testing will be conducted at each site by field site AF and AT personnel after the system has successfully completed installation and check-out (INCO) testing and SAT. Field familiarization will follow contract acceptance inspection (CAI) and lead to IOC. IOC will be the declaration by site personnel that the (sub)system is ready for conditional operational use in the NAS and will denote the end of field familiarization at that site.

Field familiarization tests at each field site may include:
a) Testing to confirm that the system can be safely transitioned to a secure system;
b) Testing to confirm that all security requirements are implemented;
c) Testing to confirm that the system is functionally and operationally suitable;
d) Testing to confirm that the system can be certified without degrading other system operations;
e) Maintenance testing to confirm that hardware and software maintenance can be completed without degrading system performance and security;
f) Failure Mode testing to confirm that the system can report, recover, reconfigure if necessary, and be repaired and recertified without degrading system performance; and
g) Portions of IOT&E, if applicable.

Field familiarization tests will be designed such that any residual operational deficiencies that the new (sub)system might have are revealed before IOC.

Typical entrance criteria for field familiarization tests are:
a) CAI is successfully completed
b) Test plan and procedures are approved and ready
c) Hardware/software are at correct release/revision levels
d) Certification procedures are in place
e) Documentation and maintenance handbooks are in place
f) Test equipment and tools are in place
g) Site personnel are adequately trained and ready for testing
h) There are no open test-critical PTRs.

Typical field familiarization test exit criteria are:
a) Successful completion of the field familiarization test plan.
b) AF/AT final test report submitted; AF/AT test directors recommend proceeding to IOC.
c) Successful regression testing of any hardware/software releases/revisions that were installed during testing.
d) No Test Critical or Type 1 PTRs outstanding and no more than a predefined number of non Type 1 PTRs open.
e) AF/AT managers declare IOC.

4.2.2 IOT&E

ATQ will lead the ATS test team for IOT&E, consisting of AT and AF operational experts. The ATS test team will first monitor the system test, and then will perform the IOT&E, assessing the operational readiness of the system based on identified COIs from Section 4.1 of this document. The ATS test team will report their results to ATS-1.

4.3 Methods of Verification

The following verification methods will be utilized in measuring equipment performance and compliance of individual requirements contained in the purchase description of each NEXCOM Subsystem. The four verification methods, (TEST, DEMONSTRATION, ANALYSIS, and INSPECTION), listed in decreasing order of complexity, are described as follows:

1. <u>TEST.</u> Test is a method of verification wherein performance is measured during or after the controlled application of functional and/or environmental stimuli. Quantitative measurements are analyzed to determine the degree of compliance. The process uses laboratory equipment, procedures, items, and services.

2. <u>DEMONSTRATION.</u> Demonstration is a method of verification where qualitative determination of properties is made for an end item, including the use of technical data and documentation. The items being verified are observed, but not quantitatively measured, in a dynamic state.

3. ANALYSIS. Analysis is a method of verification that consists of comparing hardware design with known scientific and technical principles, procedures and practices to estimate the capability of the proposed design to meet the mission and system requirements.

4. INSPECTION. Inspection is a method of verification to determine compliance without the use of special laboratory appliances, procedures, or services, and consists of a non-destructive static-state examination of the hardware, the technical data and documentation.

5.0 NOTES

5.1 Government Furnished Property

The MDT hardware and operating systems are considered government furnished property for the development of the NEXCOM System and subsystems. The MDR is also considered government furnished property for the development of the NEXCOM System and subsystems.

5.2 ICAO Standardization Agreements

VDL Mode 3 technical manuals are due for publication in mid-2002.

5.3 Other Guidance Material

5.4 References

APPENDIX A

Current NAS A/G Configurations

A.1.0 CURRENT SYSTEM ARCHITECTURE

The current A/G Communications System for ATC consists of voice-based networks that use DSB-AM radios and operate in the 117.975-137 Megahertz (MHz) VHF band for civil aircraft and the 225-400 MHz UHF band for military aircraft. The radios operate with the same frequency used for controller-to-pilot (uplink) and pilot-to-controller (downlink) transmissions in a simplex "push-to-talk" mode. There is a dedicated, non-interconnected radio network for each operational environment (En Route, Terminal, airport surface, and flight service). In the event of a control facility power loss, engine generators provide back-up power. In the event of equipment failure, A/G communications are provided Back-Up Emergency Communications (BUEC) in the Enroute, Emergency Communications System (ECS) in the large TRACONS and portable transceivers in the smaller TRACONS and Air Traffic Control Towers (ATCT).

The current A/G communications system architecture is roughly the same for all operational environments. The specific equipment used in the A/G communications string can differ among the various facilities. Different control facility types have different voice switches, with each type of switch having a unique interface. There were three types of radio control equipment; Grim, Intelect, and CSTI RCE. All of the Grim and most of the Intelect equipment has been replaced by the CSTI RCE. The CSTI RCE was designed to emulate the 12 VDC interface of the Grim and the contact closure interface of the Intelect. The CSTI RCE has been modified to emulate the interface of the BUEC Priority module.

A.2.0 NAS COMMUNICATIONS FACILITIES

The major components of the current system can be broadly divided as follows:
a) Area Control Facility (ACF) equipment
b) Remote Communications Facility (RCF) equipment
c) Transport media

The ACFs are the control sites and RCFs are the associated remote A/G radio sites. Table A-1 summarizes specific facility relationships and radio configurations of the A/G communications facilities utilized in the NAS. The various configurations are discussed in Section A.3.

Table A-1

ACF/RCF Relationships

ACF Type	RCF Type	Configuration
ARTCC/CERAP	RCAG	T/R, M/S, STR
	BUEC	T/R (Main only)
	Local	T/R, M/S, STR
ATCT	RTR	T/R, M/S, STR
	Local	T/R, M/S, Emergency

Table A-1

ACF/RCF Relationships (continued)

ACF Type	RCF Type	Configuration
TRACON/RAPCON	RTR	T/R, M/S, STR
	Local	T/R, Emergency
AFSS/FSS	RCO	T/R, M/S, STR
	Local	T/R, M/S, Emergency

***Note*:**
T/R = Transceiver configuration
M/S = Main/Standby (Transmitter or Receiver) configuration
STR = Separated Transmitter and Receiver sites
RTR = Remote Transmitter Receiver (a.k.a. as RT (remote transmitter site) if it only contains transmitters or as a RR (remote receiver site) if it only contains receivers.)
RCO = Radio Communications Outlet
AFSS = Automated Flight Service Station
TRACON = Terminal Radar Approach Control Facility
CERAP = Combined Center Radar Approach Control
Emergency = Emergency Transceivers (e.g., PET-2000)

A.2.1 Area Control Facilities (ACF)

Figure A-1 provides a general concept of the interrelationships between the various ACFs within the NAS. The three types of FAA control facilities (En Route, Terminal, and flight services) include respectively ARTCCs and Combined Center Radar Approach Control (CERAPs), ATCTs and TRACONs/RAPCONs, and AFSS/FSSs. A control facility may have a collocated RCF. Most facilities use separate RCFs, but some RCF locations may be shared by different ACFs.

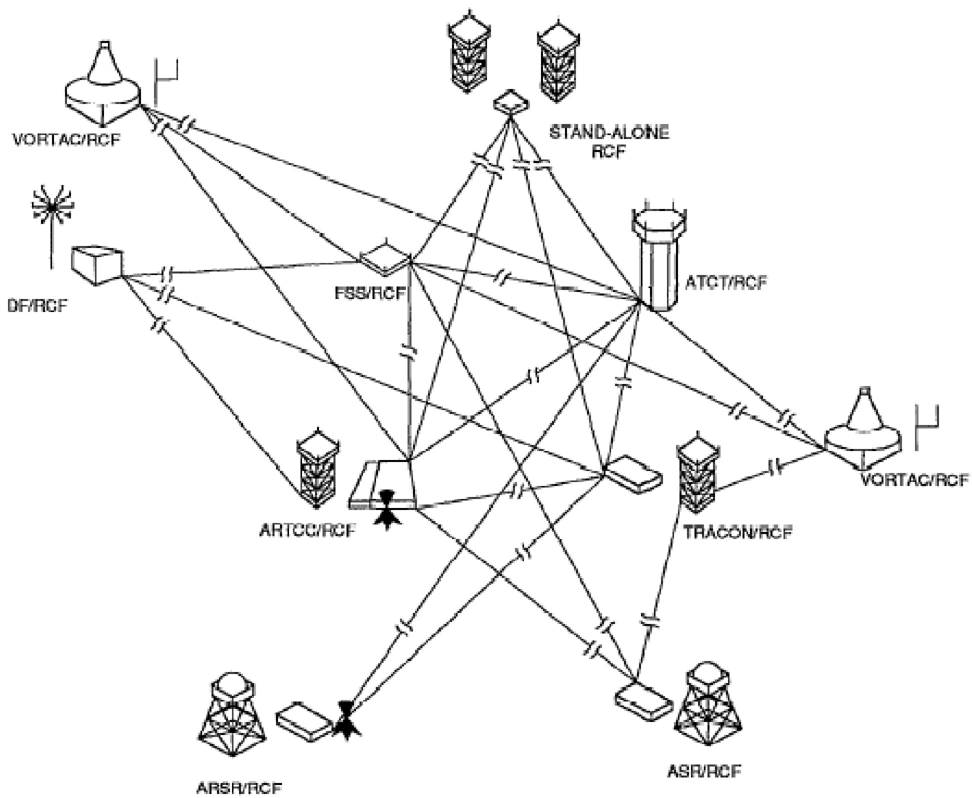


Figure A-1

ACF to RCF Diagram

A.2.1.1 ARTCC and CERAP

ARTCCs and CERAPs are responsible for En Route air traffic control for all civil and military aviation. Each ARTCC has well defined airspace boundaries and is responsible for all airspace within these boundaries that has not been delegated to Terminal ATC facilities. Each ARTCC and CERAP has RCAG and BUEC (planned for CERAPs) remote radio facilities to support En Route A/G communications. Also, local RCAGs and BUECs are installed in the ARTCCs and CERAPs. Figure A-2 illustrates the current En Route A/G communications system.

Depending upon channel configuration, RCAGs may have a paired set of VHF/UHF radios that allow the air traffic controllers to simulcast over VHF and UHF frequencies to control both civilian and military aircraft. After the BUEC expansion program is concluded, a pair of remote sites per sector, one RCAG and one BUEC site, will provide adequate support for approximately 75 to 80% of the currently defined En Route sectors and the remaining 20 to 25% is provided through diversity sites. The local RCAGs and BUECs provide the close-in coverage in the vicinity of the ARTCC and CERAP.

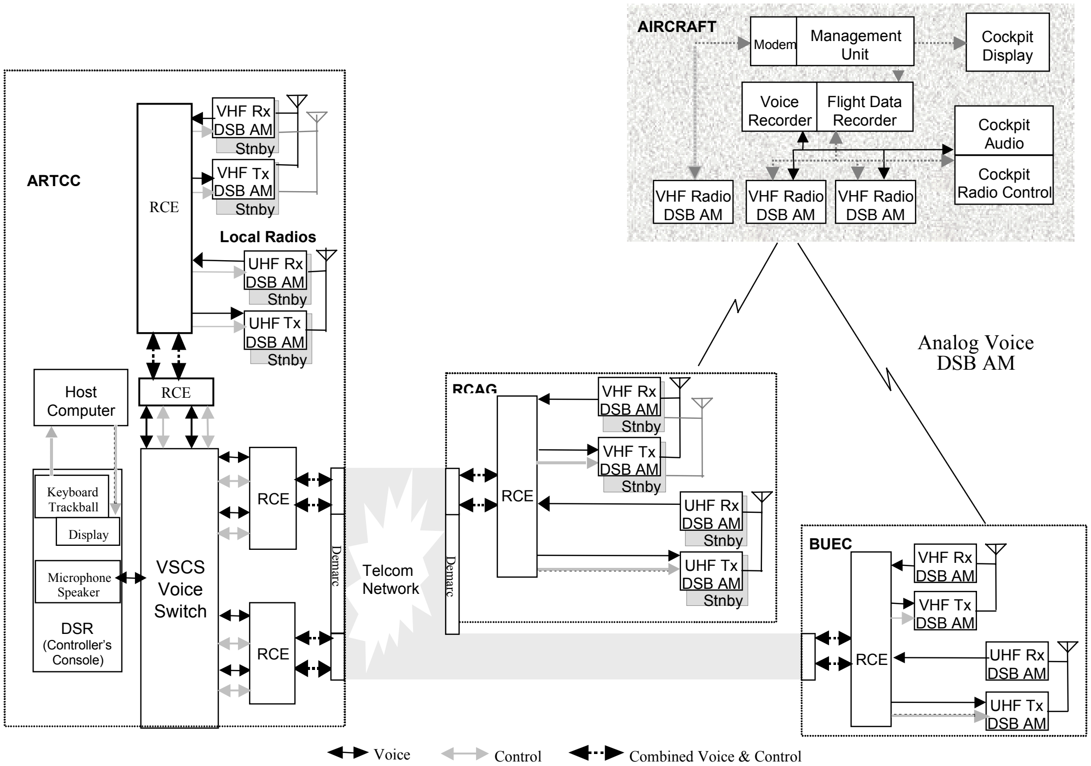


Figure A-2

Current En Route A/G Communications System

An ARTCC also can support a multi-RCAG site grouping commonly referred to as a Diversity Site Group. A diversity site group (reference to Section A.3.2.2) is used to extend A/G communications coverage for a controller of a large sector. In this configuration, there can be two to six RCAGs, each with its own BUEC, providing A/G communications support for that sector on one frequency (or frequency pair VHF/UHF).

The VSCS Training and Backup System (VTABS) can provide backup capability for a limited number of AT controllerpositions.

A.2.1.1.1 Controller's Display Console

The controller's display console provides the human interface for the voice switch, including the PTT switch, microphone, radio selection switches, and radar display of the airspace for which the controller is responsible.

A.2.1.1.2 Voice Switch

The voice switch provides the ability to control the connectivity of both A/G and G/G voice circuits. It may also include additional logic control functions associated with these circuits to maintain priority for controller shared remote sites or to interpret for an ARTCC controller the selection of old BUEC transceiver equipment that does not use RCE. Each ARTCC utilizes a

VSCS to interface with all of its RCAG and BUEC sites. Voice signals to RCAGs are routed by the voice switch to a control site RCE that is connected to its remote site RCE counterpart through a dedicated telecommunications transmission system. The electrical interface to the VSCS for each of these facilities is contained in the VSCS ICD, NAS-IC-41024000 and NAS-IC-64024201. The major functions of the voice switch are:

a) Interpretation and processing of controller commands.
b) Selection of voice circuit/connectivity.
c) Circuit/system status indication.
d) Switching between input and output paths.

A.2.1.1.3 Control Site RCE (C-RCE)

The major functions of the C-RCE units are:

a) Provision of VHF/UHF paired frequency operation (capable of independent selection of main, standby, transmit and receive operations)
b) Reception of audio inputs via RCE-Voice Switch interface
c) Transfer of remote radio control signals (e.g., push-to-talk, main/standby transmit/receive selection) from controller to remote site
d) Provision of control and audio routing through RCE-Radio interfaces for both VHF and UHF main/standby transmitters and receivers.
e) Allow flexible control of the audio and signaling routing via remote means

The C-RCE can emulate three legacy interfaces, if required, for voice switches and used in the NAS to connect to an RCF or sustaining BUEC (S-BUEC) site. Those legacy interfaces are a +12 VDC interface (i.e. Grim) and a contact closure interface (i.e., Intelect 5134C). For a complete description of these two interfaces refer to the VSCS ICD (NAS-IC-42014000) and the RCE specification (FAA-E-2885).

The BUEC interface is unique and originally interfaced the old BUEC transceiver system to the voice switch. Today the BUEC interface is emulated by the VSCS to interface to an old BUEC Priority Module or C-RCE. For a complete description of the older BUEC interface refer to the VSCS IRD (NAS-IC-64024201).

Some CERAPs now utilize RCE to provide the control interface to local radios and to BUEC sites. Without RCE, local radios typically were keyed via +24 VDC or a ground loop (contact closure). Figure A-3 depicts a previously used typical Local Radio implementation without RCE.

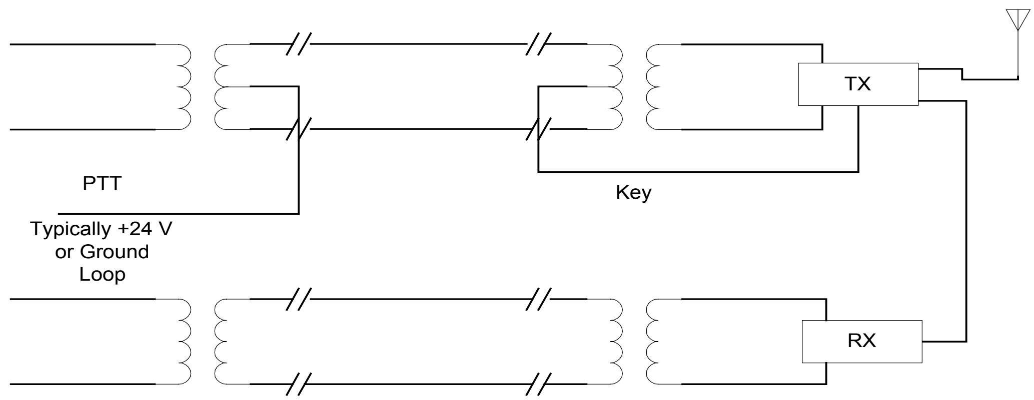


Figure A-3

Local Radio

A.2.1.2 Airport Traffic Control Tower (ATCT)

Tower air traffic controllers authorize aircraft movements including takeoffs, landings, and airport area movements, regardless of flight plans or weather conditions. The current FAA A/G Communications System also provides limited support for two-way A/G data communications by providing Pre-departure Clearance (PDC) and Digital Air Traffic Information Service (D-ATIS) messaging at 57 airports via the Tower Data Link Service (TDLS) using ARINC's Aircraft Communications Addressing and Reporting System (ACARS) network. A/G communications are normally via RTR A/G radio facilities, but also may involve voice broadcast on other facility transmitters. The Voice Switch Bypass (VSBP) can provide the backup capability for a limited number of frequencies at a limited number of positions.

A.2.1.3 Terminal Radar Approach Control (TRACON)

TRACON controllers use radar/Beacon and computer capabilities to provide approach control services to aircraft arriving, departing, or transiting airspace controlled by that particular facility. Similar facilities are the U.S. Air Force (USAF)/FAA Radar Approach Control (RAPCON) facilities and the U.S. Navy Radar Air Traffic Control Facilities (RATCFs). A/G communications are usually via the Terminal A/G radio RTR facilities shared with the local ATCT. The Voice Switch Bypass (VSBP) can provide backup capability for a limited number of frequencies at a limited number of positions.

A.2.1.4 Automated Flight Service Station (AFSS)/Flight Service Station (FSS)

The AFSS is a computerized central operations facility that combines and automates the functions of two or more FSSs at a single location. The AFSS provides automated data acquisition and transmission capability for centralized flight plan processing; weather information consolidation and dissemination; Notice to Airman (NOTAM) services; pilot briefings; and other En Route, Terminal and airport advisory services. A/G communications from an AFSS are via RCO A/G radio facilities.

A.2.2 Remote Communications Facilities (RCF)

There are four different types of RCF facilities; RCAG and BUEC for ARTCC support, Emergency Communications System (ECS) for TRACON support, RTR for ATCT and TRACON support, and RCO for AFSS support. Figure A-4 defines the designated type of RCF associated with each control facility. (See Table A-1)

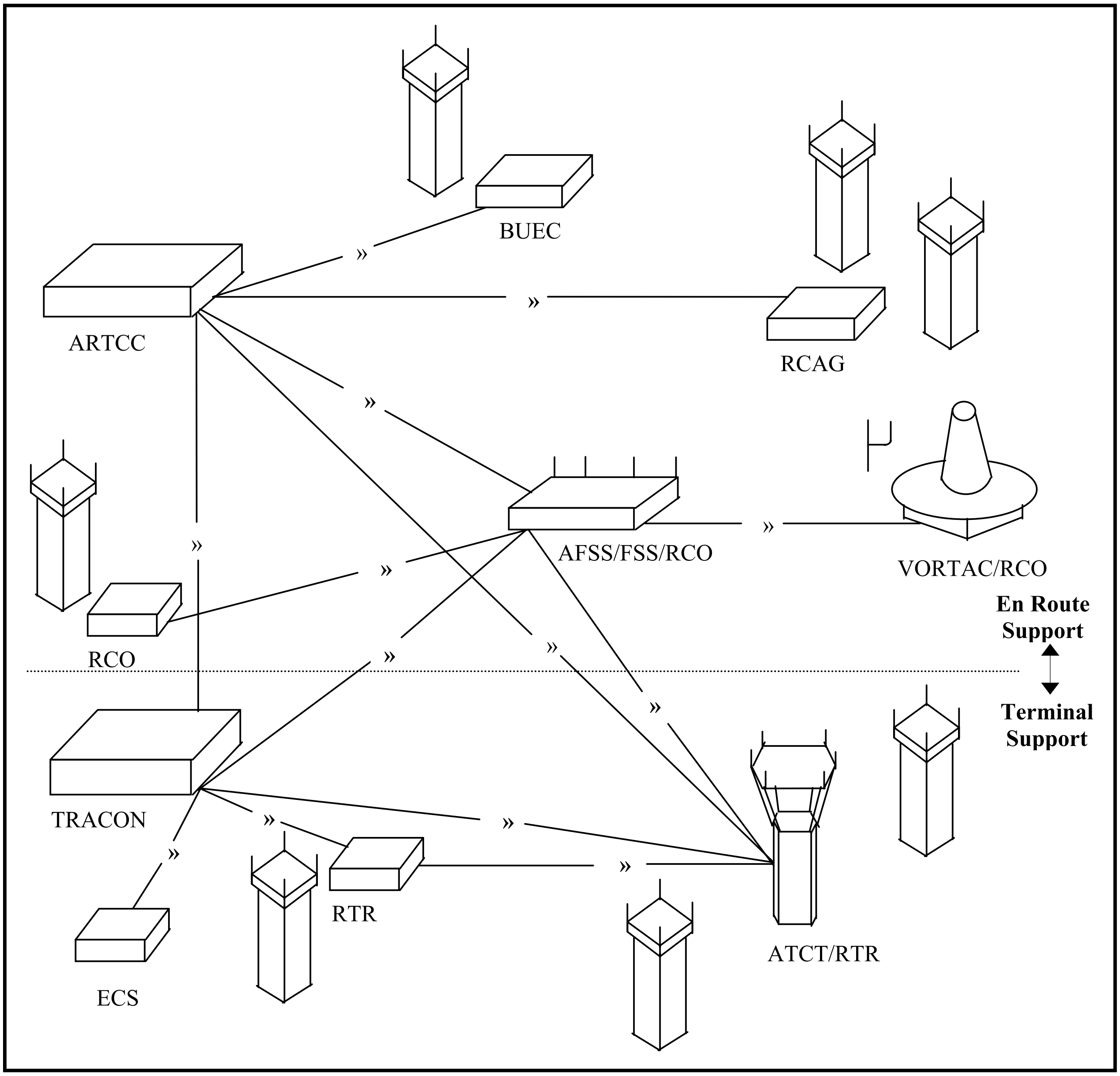


Figure A-4

Typical RCF Types For Specific Control Facilities

Note: *An RCF may be collocated with its control facility or with another facility, on a non-interference basis, and in some cases, a single RCF may serve more than one type of control facility.*

A.2.2.1 Remote Center Air/Ground (RCAG) Facility

An RCAG is typically an unmanned remote A/G radio facility that expands A/G communications coverage for an ARTCC and provides direct radio contact between pilots and controllers. RCAGs typically are located remote from the ARTCC. Depending on the sector being provided coverage, an RCAG could be on top of a mountain, in the middle of the desert, or near a large metropolitan area. Each RCAG contains redundant VHF and UHF transmitters and receivers and one CSTI RCE for each operational VHF/UHF frequency pair. VHF and UHF radio equipment are usually paired to share the same voice channel. This allows them to share a telecommunications line for control signaling and to share radio control equipment required to demodulate radio control signals to transfer equipment between main and standby.

A.2.2.2 Back Up Emergency Communications (BUEC) Facility

A BUEC facility provides a one-for-one channel backup for an RCAG facility. BUEC channels purposely use independent transmission paths from the ARTCC with respect to its matching RCAG channel. The BUEC system's redundant VHF and UHF communication channels are selectable by the ARTCC controller for immediate use whether or not any primary RCAG frequency fails. BUEC facilities provide only main transmitters and receivers, not standby transmitters and receivers. BUEC radios are typically configured the same as in an RCAG, in a TX/RX configuration. Older tunable DSB-AM transceivers are still in use in some BUEC sites; however, there is an ongoing BUEC improvement program that will replace the existing transceivers with separate transmitters, receivers, and RCE. Also, BUEC facility power sources and lines are totally separate from the corresponding services provided to the RCAG facility handling the primary A/G communications. BUEC facilities may be collocated with various NAS facilities such as RCAGs (not same frequency as BUEC), RTRs, RCOs, RCL sites, LDRCL sites, VHF Omni-directional Range (VOR)/distance measuring equipment (DME), VORTAC, or ILS sites.

A.2.2.3 Remote Transmitter/Receiver (RTR)

RTR facilities provide pilot and controller voice communications in the TRACON and ATCT areas. Civil/military joint use areas must have both VHF and UHF equipment installed. RTR facilities in less congested areas may house equipment used for other than Terminal ATC, e.g., BUEC, RCAG and RCO functions. Control, voice, and data circuits to these facilities may be FAA-owned and maintained. RTR facilities have several different configurations, depending on the needs for the Terminal area. The transmitters and receivers may be located at separate sites and/or the main and standby equipment may be at separate sites. *Note: If the RTR contains only transmitters or receivers it is known as an RT (remote transmitter) or RR (remote receiver) site.* However, each RTR VHF or UHF channel will consist of four radios, two transmitters (M/S) and two receivers (M/S). RTR sites are typically located on the airport, however some RTR sites may be located several miles from the airport in order to achieve necessary coverage/diversity for the supporting TRACON/ATCT. Figure A-5 shows a typical RTR site configuration for an airport.

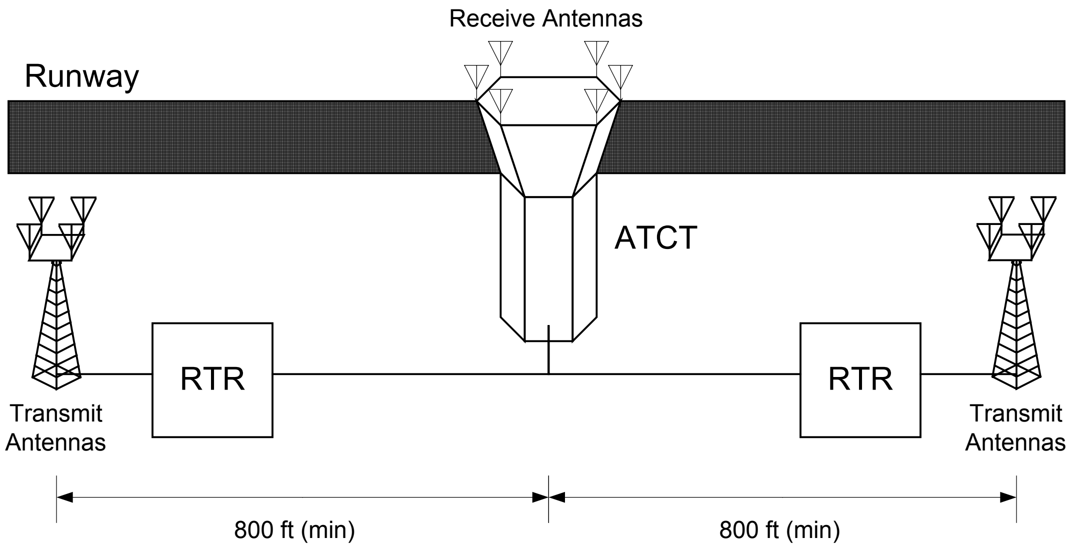


Figure A-5

Typical RTR Site Configuration

A.2.2.4 Remote Communications Outlet (RCO)

RCOs are remote A/G radio communications facilities that provide A/G links between AFSS/FSS specialists and pilots flying in FSS flight advisory areas. RCOs typically are collocated with other FAA facilities such as RCAGs, BUEC, RTRs and VOR facilities. VOR collocated RCOs may use their voice transmitter capability as the FSS link to pilots with the receiver link located at the same site. Typical RCO facilities contain VHF transmitters and receivers (M/S) and some UHF transmitters and receivers (M/S).

A.2.2.5 ECS Equipment

Currently, ECS equipment consists of remote site RCE units, analog transmitters, receivers, power systems, cable, antennas, and where required to reduce RFI/EMI, transmitter combiners and receiver multicouplers.

A.2.2.6 RCF Equipment

Currently, RCF equipment consists of remote site RCE units, analog transmitter, receivers, power systems, cable, antennas, and where required to reduce RFI/EMI, transmitter combiners and receiver multicouplers.

A.2.2.7 Remote Site RCE (R-RCE)

The CSTI R-RCE unit receives combined audio and control signals from the control site via a telecommunications (terrestrial, microwave, or satellite) medium. The interface is designed for an analog 4-wire voice circuit. The R-RCE separates the control signals from the audio before delivering them to the radio interface. The R-RCE also receives downlink audio signals from the A/G radio interface and puts them into a format suitable for transmission back over the analog 4-wire voice circuit. RCE supplies the proper electrical characteristics to interface to that circuit.

A.2.2.7.1 A/G Radios

At primary A/G radio remote sites there are typically eight radio units associated with a voice channel. This includes main and standby units for transmitters and receivers operating in both the VHF and UHF bands. All radios are interfaced to the remote site RCE units and either directly to site antennas or to antenna transfer relays. Currently, radios used for main and standby communications are fix-tuned analog radios. Because of fixed-tuned cavity filters within the radios, adjustment of frequencies requires on site technician to perform the retuning of the cavity filters or swapping out radios for replacement by radios with cavity filters pre-tuned to the new frequencies desired.

A.2.2.7.2 Transmitters

Transmitters receive audio and push-to-talk signals from the remote site RCE and generate modulated RF signals that are provided to the antenna. Output power is typically 10 watts, but some transmitters use a 50-watt linear power amplifier (LPA) for extended range. Multiple transmitters may be connected to a transmitter combiner for output to the antenna at remote facilities where co site interference problems exist or to reduce congestion on antennas/towers where many operational frequencies are in use.

A.2.2.7.3 Receivers

Receivers accept modulated RF signals from an antenna and amplify, down-convert, and demodulate the signals to supply audio to the remote site RCE. Multiple receivers also may be connected to a receiver multicoupler to reduce congestion on antennas/towers where many operational frequencies are in use.

A.2.2.7.4 Antennas

A transmitter and receiver pair may be connected to one or more antennas, depending on the desired configuration. Main and standby radios are frequently connected to separate antennas for diversity. An external antenna transfer relay or internal transmitter relay is used to switch between separate transmitters and receivers operating with a common antenna. At many sites, antennas providing diversity are separated to provide transmit/receive isolation. Some sites utilize 4 dBi omni-direction and 10 to 12 dBi directional antennas.

A.2.3 Telecommunications Media

The Control and Remote site RCE's interface through the telecommunications media, which could be landlines (analog or digital, leased or owned), microwave, fiber optics, or satellite links. The supplied media could also employ two or more of the above-mentioned services. The present communications path being provided for radio circuits is a Voice Grade 6 with no monitoring tone provided in FAA Order 6000.22A. Many of the communications paths are also provided by the FAA's RCL and LDRCL infrastructure. Satellite communications (FAATSAT and ANICS), also provides service in some difficult access areas. When backup sites are used, the FAA has a diversity plan that it implements and will make every attempt to keep the primary and backup services on separate/different telecommunications media. When this is not possible the supplied services provided to the primary and backup radios will not share the same Central Office thus providing diversity paths. FAA owned fiber and cable are usually the media used at the facilities located on or around the airports being serviced.

A.3.0 RCF Radio Configurations

The following subsections describe typical RCF radio configurations and typical ACF/RCF control configurations.

A.3.1 RCF Tx/Rx Configurations

An RCF may have one Tx/Rx configuration or a combination of Tx/Rx configurations. The following sections describe the various transmitter and receiver configurations/locations that are utilized at the majority of the RCF facilities in the NAS today.

A.3.1.1 Transmit/Receive (T/R)

In the T/R configuration, the transmitter and receiver pair are connected to the same antenna via an antenna transfer relay located in the transmitter. When an LPA is added, an external Antenna Transfer Relay may be utilized in place of the transmitter's internal relay. This configuration is typical in many RCAGs, BUECs, RCOs, and some RTRs. Figure A-6 depicts a simplified view of the T/R configuration. Figure A-7 depicts one possible site configuration for groups of T/R antennas.

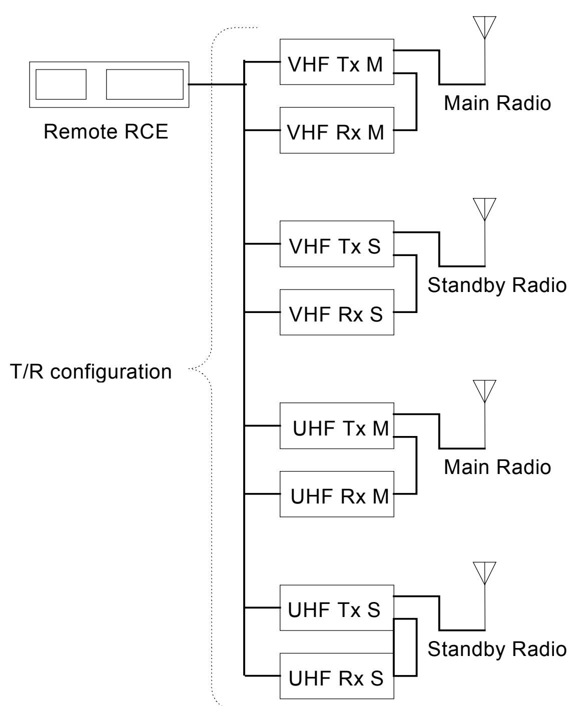


Figure A-6

T/R Configuration

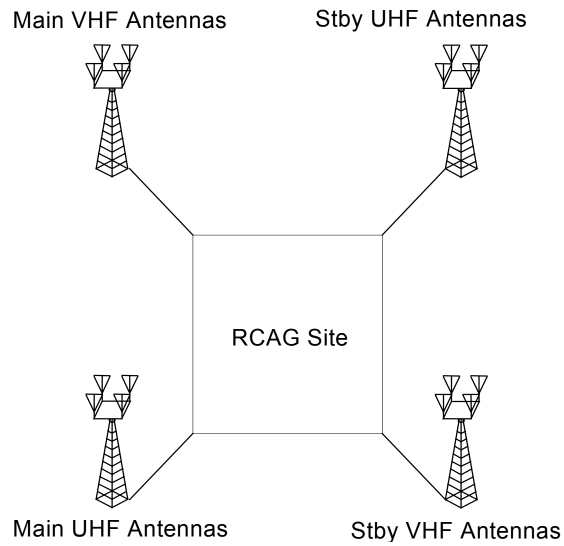


Figure A-7

Site Diagram for T/R Configuration Antenna Groups

A.3.1.2 Main/Standby (M/S)

In the M/S configuration, the antenna is typically connected to an external Antenna Transfer Relay (ATR). The main transmitter and the standby transmitter are then connected to the antenna transfer relay (similarly for the receivers). In some cases, the main transmitter's internal antenna relay is used instead of the external ATR. The M/S receivers may also be connected in series so that input from the antenna is present at both receivers. Figure A-8 depicts a simplified view of the typical M/S configuration. Figure A-9 depicts a typical site configuration for the M/S connected antennas.

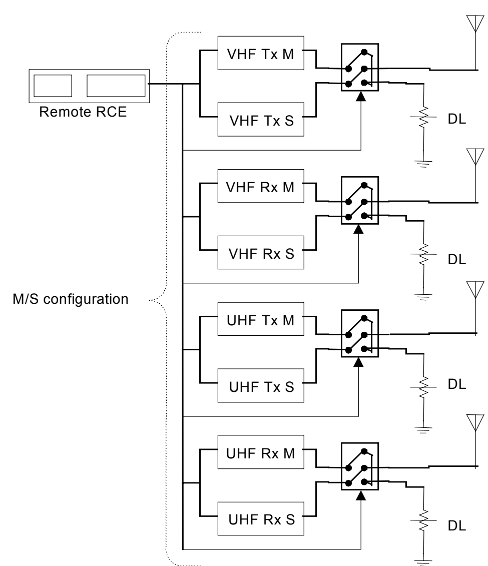


Figure A-8

Diagram for Radios in M/S Configuration

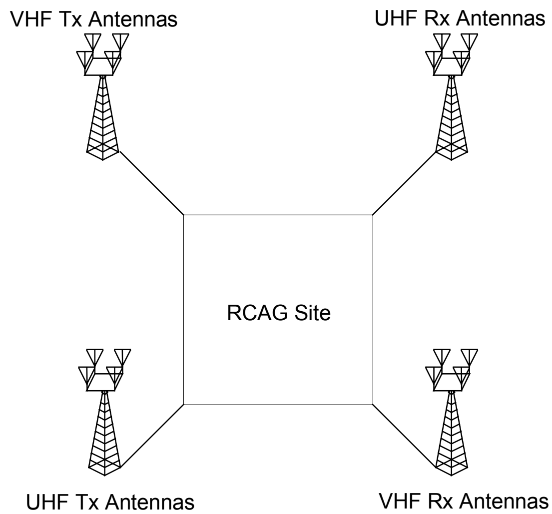


Figure A-9

Antenna Site Diagram for the M/S Radio Configuration

A.3.1.3 Separate Transmitter/Receiver (STR)

In the separate Tx/Rx configuration (STR), some antennas are connected to a transmitter combiner or a receiver multicoupler and then connected to several transmitters or receivers respectively. The transmitters and receivers may be collocated in the same facility or may be located in separate facilities. Figure A-10 depicts a simplified view of the STR configuration. Figure A-10a depicts the typical STR configuration. Figure A-11 depicts a typical site configuration of the antennas.

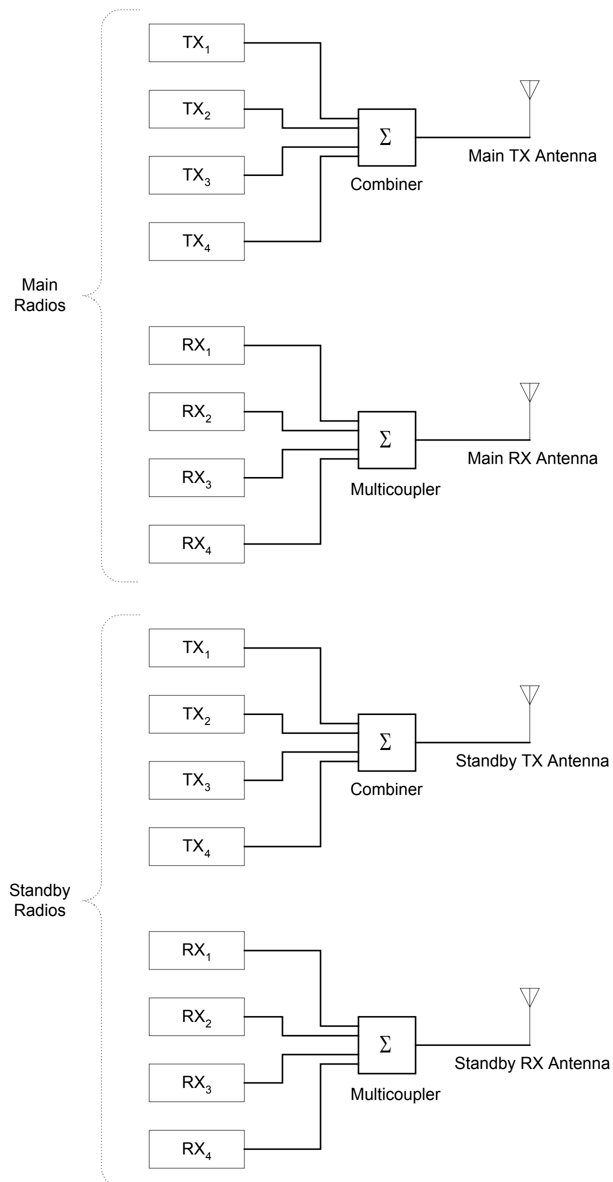


Figure A-10

STR Configurations Using Combiners/Multicouplers

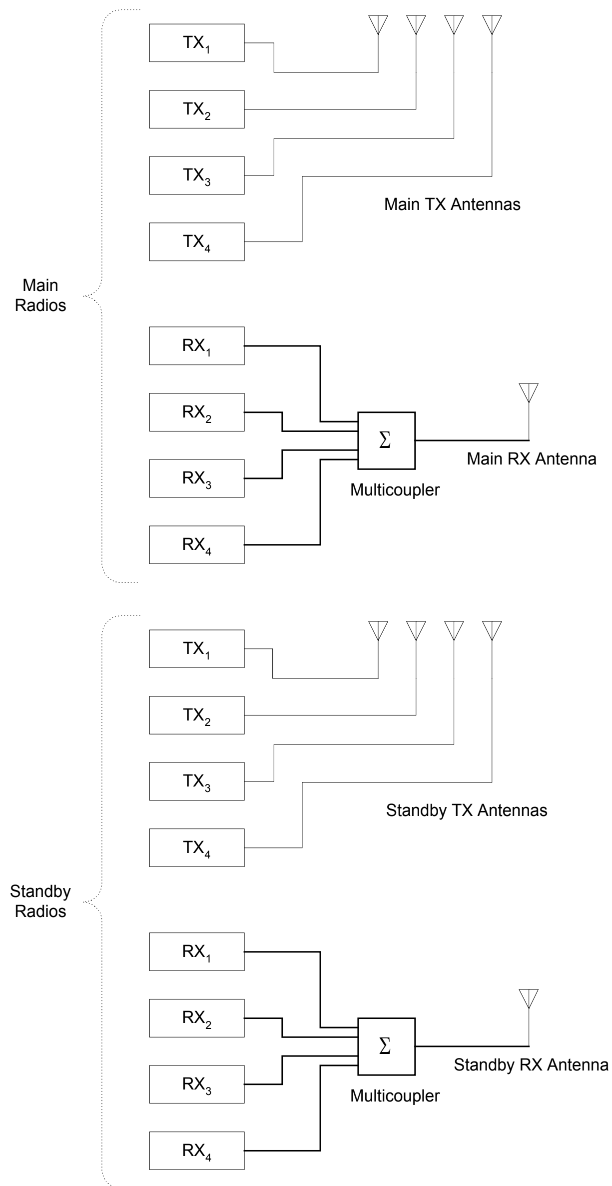


Figure A-10a

Typical STR Configurations Using Only Multicouplers

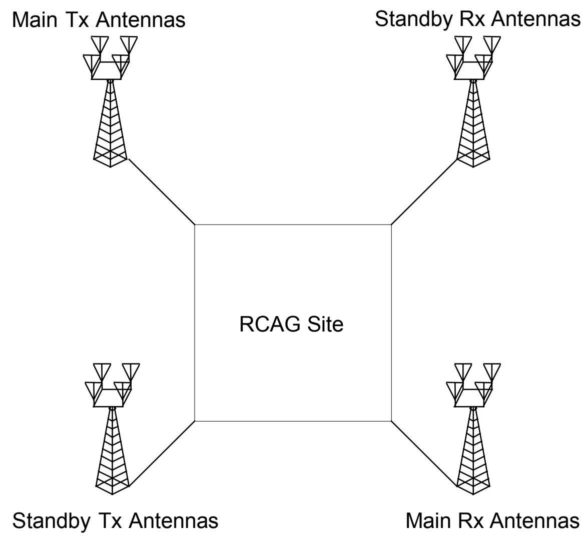


Figure A-11

Site Diagram for STR Antenna Configuration

A.3.2 RCF Control Configurations

For each RCF channel, there are different control possibilities. The standard is for one ACF to control each remote VHF/UHF channel or frequency. The following sections discuss the other two most prevalent control configurations.

A.3.2.1 RCE Dual Control

A dual control configuration exists between two ACFs and one RCF channel. As indicated in Figures A-12 and A-13, the RCE provides the capability to allow two control facilities to utilize a single remote VHF/UHF channel or a single frequency. A typical application for dual control is where a tower will be manned and operated during normal business hours and then be turned over to another ACF that is manned 24 hours a day. The RCE provides for both a non-priority and priority mode of simultaneous control. Refer to the RCE specification, FAA-E-2885, for more details of RCE dual control mode.

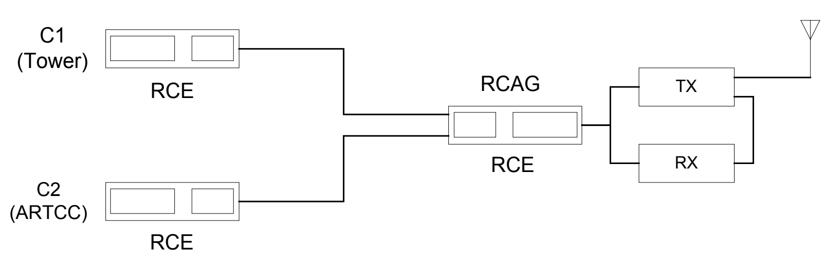


Figure A-12

Dual Control Using RCE

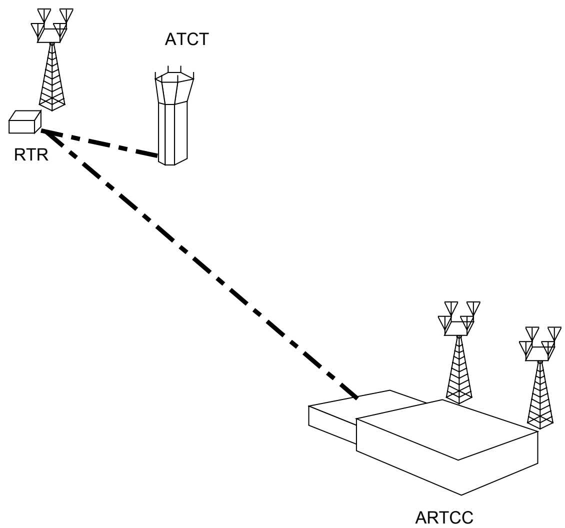
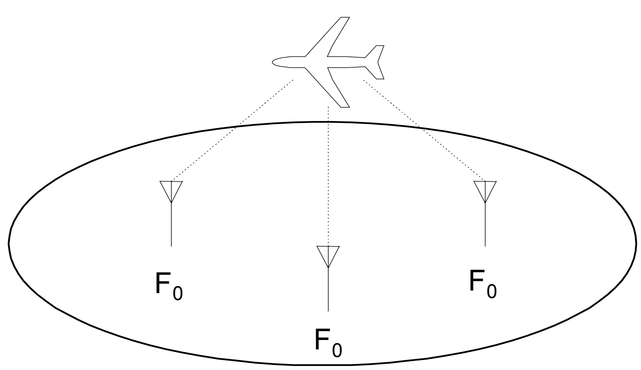


Figure A-13

Dual Control Site Diagram

A.3.2.2 Diversity Site Groups

The VSCS supports a multi-RCAG/BUEC site grouping commonly referred to as a Diversity Site Group. In this configuration, there can be from 2 to 6 RCAG facilities, with up to 6 BUEC facilities, for as many as 12 radio facilities for one large sector, operating on the same frequency to support A/G voice communications for the Talk Group. In some cases, this is implemented using multiple frequencies. The diversity site group allows an operator the ability to transmit from the selected transmitter or listen on up to 6 radio receivers on the same frequency. The operator can only key one transmitter at a time based on operator selection. All receivers can be active at the same time with VSCS selecting a single downlink voice signal based on the specific selection algorithm implemented and present it to the operator's headset for use. Figure A-14, illustrates the diversity site group concept.



Multiple sites on same frequency in same sector.

Figure A-14

Diversity Site Group

APPENDIX B

NEXCOM System Architecture

B.1.0 INTRODUCTION

The A/G Communication System is required by the FAA to support services that ensure aircraft separation, transmit instructions and clearances, permit hand-offs, provide weather information and pilot reports, and communicate with AFSS/FSSs. Different subsets of these services are required to support different phases of flight, including ground movements on the airport surfaces and in gate areas; departures and arrivals in the Terminal area; and the En Route phase of flight. The NEXCOM System is the next generation A/G communications system that implements VDL Mode 3 standards and provides integrated voice and data services, and other operational enhancements over the current analog voice only system. This section describes the VDL Mode 3-based NEXCOM System architectures to include the sustainment system and the end-state system.

B.2.0 NEXCOM SERVICES

The NEXCOM System provides the following services:
a) Voice
b) Point-to-point data
c) Uplink data broadcast.

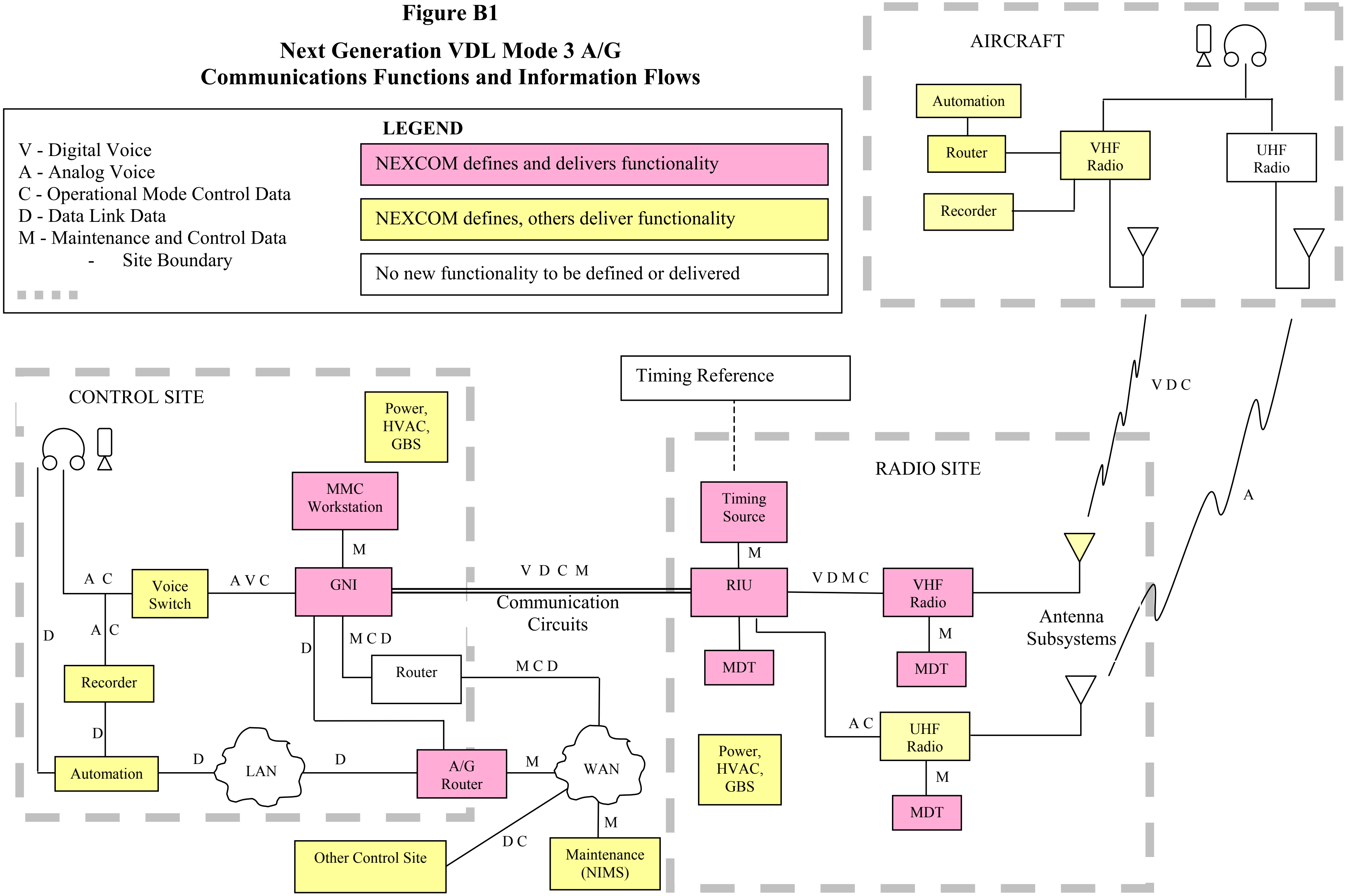
B.3.0 NEXCOM SYSTEM DESCRIPTION

Figure B-1 is a simplified block diagram of the next generation A/G communications system, illustrating the key functional blocks of the A/G communications system in the NEXCOM end state. Figure B-1 identifies three types of functional blocks and how they are interconnected:
a) NEXCOM defined and delivered elements,
b) legacy system elements where enhancements or modified functionality are expected, and
c) legacy system elements that are not impacted by NEXCOM.

The NEXCOM defined and delivered functionality is defined in this SRD to include the following subsystems:
a) MDR
b) RIU
c) GNI
d) A/G Router
e) Timing Source
f) MDT Software Element
g) MMCWS

Figure B1

Next Generation VDL Mode 3 A/G
Communications Functions and Information Flows



Legacy system elements where enhancements or modified functionality are expected include the following elements:

a) VSCE
b) Automation
c) Recorder
d) NIMS
e) UHF Radio
f) Power, HVAC, and GBS
g) Telecommunications Links

The enhancements and modified functionality represent requirements imposed on the legacy equipment by the NEXCOM System.

Legacy elements that are not expected to be affected by NEXCOM include general networking elements, such as LAN and WAN, and the antenna subsystems.

The NEXCOM Subsystems are briefly described in the following subsections.

B.3.1 MDR Transmitter and MDR Receiver

The MDR subsystem is the FAA VHF ground radio element of the NEXCOM System. It is a multi-mode radio providing selectable operating modes of 25 kHz DSB-AM, 8.33 kHz DSB-AM, and VDL Mode 3. The MDR subsystem is specified to be a direct replacement for the current generation 25 kHz DSB-AM radios with the purpose of sustaining the current DSB-AM A/G communications ground system infrastructure. The MDR subsystem implements the physical layer, the MAC sublayer processing functions of VDL Mode 3, and other radio and modulation functions. The MDR subsystem will be implemented as separate MDR transmitter subsystems and MDR receiver subsystems.

In sustainment, the MDR subsystems will operate in 25 kHz DSB-AM mode and continue to interface to the legacy RCE and antenna subsystems. In the End-State, the MDR radios in conjunction with the other NEXCOM Subsystems and other A/G communications elements, will operate in VDL Mode 3 to deliver the NEXCOM integrated voice and data services. The inclusion of the 8.33 kHz DSB-AM capability in the MDR subsystem is for risk mitigation.

To provide maximum operational flexibility, a high power version of the MDR transmitter will be procured in addition to the normal (low) power MDR transmitter. The high power transmitter will be used for any sectors to extend the coverage range to beyond 200 nmi.

B.3.2 RIU

The RIU subsystem provides most of the DLS and MAC protocol functions of the VDL Mode 3, voice encoding/decoding, MDR and UHF radio control, and acts as a RMMC agent for the MDR radios and the next generation UHF radios. Each RIU is implemented to be capable of supporting all VDL Mode 3 system configurations associated with a single 25 kHz channel assignment.

The RIU schedules all uplink and downlink data transmission over the available data slots by implementing a centralized data reservation scheme, which is based on its uplink data transmission needs, message priority, and downlink reservation requests. A possible data channel reservation algorithm is described in ICAO Doc X (Manual for VDL Mode 3 Implementation).

The RIU subsystem must support simultaneous integrated digital voice and data operation in VHF and analog voice operation in UHF. For this reason the RIU includes VDL Mode 3 standard vocoders to perform conversions between analog voice and digital voice for UHF operation in the NEXCOM end-state.

The RIU subsystem interfaces with the MDR subsystem and with the GNI subsystem located at a control facility via an interfacility communications link to provide VDL Mode 3 integrated voice and data services.

The RIU provides the timing reference for the VDL Mode 3 system. It derives system timing from an external timing source and provides system time clocks to MDR and GNI subsystems. It also controls the timing of the uplink Beacon transmissions of the MDR to provide a timing reference for the Mobile User radios.

B.3.3 GNI

The GNI subsystem provides both VDL Mode 3 voice processing and the subnetwork access protocol functions associated with transporting the VDL Mode 3 subnetwork packets. The GNI multiplexes digital voice, traffic data, and control and management data for transmission over the inter-facility communications links to its RIUs and de-multiplexes bit streams received from the RIUs into digital voice, traffic data, system management data, and MMC data. For voice processing, the GNI subsystem includes VDL Mode 3 vocoders that perform voice encoding/decoding and A/D and D/A conversions. For network functions, the GNI provides packet exchanges, header compression, subnetwork connection management functions, and link management functions, including error recovery, flow control, and packet fragmentation. Specifically, the following functions are performed:

a) The GNI provides link management functions such as link parameter negotiation/modification (through XID exchanges with the Mobile Users), link redirection, and handoff for Mobile Users transitioning between sectors within the same center, and frame formatting.
b) The GNI provides subnetwork management functions such as Join/Leave messages. Whenever a Mobile User enters the control region of a GNI, the presence of the Mobile User can be announced to any attached network routers via a Join Message. Similarly, when the Mobile User is no longer available for data transfer, a Leave message can be sent to the attached network routers.
c) The GNI subsystem performs specific ATN functions to support the ATN standards. The GNI receives data packets from the A/G Router and performs its own subnetwork header compression to improve link efficiency. The GNI system provides subnetwork interfaces for communicating ISO 8208 and CLNP packets with and without compression. The GNI supports both the Connectionless Network Protocol (CLNP) packets and connection-oriented ISO 8208 packets.

d) The GNI subsystem also performs ground switching of data frames between GNIs in neighboring ARTCCs, as needed, to minimize any disruption in communication due to network protocol initialization of the ATN system (IDRP connection). This function is known as Make-before-Break (MbB).

For data service, the GNI interfaces with the A/G Router through a GNI Data Switch function. The GNI Data Switch functions as a switch, which reduces the workload and interface requirements of the A/G Router, necessitated by the large number of GNIs and a limited number of A/G Routers. The data switch function can be implemented as a physically separate entity or integrated with some of the GNIs or with the A/G Router. In the former, a single GNI Data Switch function will be collocated with each A/G Router per ARTCC. In integrating the GNI Data Switch Function with the ARTCC GNIs, the ATN data to and from a GNI located at the Terminal environment will be routed through an ARTCC GNI to access the A/G Router collocated with the ARTCC GNI.

The GNI subsystem interfaces to the VSCE, the A/G Router, the NIMS, the MMC WS, and via inter-facility communications links to the RIU. The GNI interfaces through the A/G Router with the automation system to receive the next channel frequency information to uplink the Next Frequency message.

For MMC, the GNI provides concentration for all NEXCOM MMC data, serves as NIMS proxy agent for the RIU and MDR, provides an interface to NIMS for the NEXCOM System, and interfaces to the NEXCOM MMC Workstation.

B.3.4 A/G Router

The A/G Router provides routing to establish communications between any ground location, which has access to the router, and any ATN-equipped Mobile User in the world. The A/G Router provides the intelligence to route data to any Mobile User with the correct ICAO address, taking into account that the Mobile Users are mobile, more than one data link service (including VDL Mode 3) can be used for delivery, and multiple links or paths are available for making the connection. The A/G Router implements the Inter-Domain Routing Protocol (IDRP), which distributes the Mobile User path information among the ATN backbone routers and is also used by the Mobile User to inform the ground routers that it is available.

The A/G Routers are currently envisioned to be collocated at ARTCCs, one per ARTCC, to reduce the capacity impact of IDRP connection changes due to the restricted bandwidth available to the NEXCOM System. Terminal GNIs will have to be routed through a GNI Data Switch function at an ARTCC to have A/G Router access for ATN data service. Each A/G Router will provide the ATN subnetwork services to the GNI within its domain. The A/G Router provides and interfaces through the Subnetwork Dependent Convergence Function (SNDCF) to support the following:

a) VDL Mode 3 8208 Packet Layer Protocol (PLP) compression
b) CLNP Frame Mode Compression
c) ATN Frame Mode.

The A/G Router is connected to the HID NAS LAN to interface with the automation system.

B.3.5 External Timing Source

The proper operation of the NEXCOM System in VDL Mode 3 requires the VDL Mode 3 system timing to be synchronized among the different ground stations sharing the same frequency in a common geographic area. Global timing synchronization of all the ground sites within NAS is not required but is assumed since synchronization to a globally available common external timing reference is desirable and is readily available, e.g., GPS.

The VDL Mode 3 system interface to the external timing source is through the RIU. The RIU derives the system timing from the external timing source, which is kept stable through synchronization to a highly accurate external timing reference. The RIU provides system timing to the MDR by controlling the timing of the uplink Beacon transmission, which is broadcast to the Mobile Users periodically and is used by the Mobile User radios to maintain accurate timing control of all Mobile User downlink transmission.

The MDRs are required to maintain their timing to within ± 10 μsec of the system reference timing established by the RIU. The external timing source includes a high stability oscillator that will maintain sufficient timing accuracy to sustain the system operation for a minimum of 30 days, in the event of an extended outage of the external timing reference.

B.3.6 MDT Software

The NEXCOM MDT software subsystem is NEXCOM specific software developed specifically to perform monitoring, maintenance, and control functions on the NEXCOM Subsystems locally and remotely. MDT access will be provided at the RIU and MDR. The NEXCOM MDT software will be installed in the standard NIMS MDT to include INFOSEC features as specified in this document to protect against unauthorized access to the NEXCOM MMC system.

B.3.7 MMC Workstation

The NEXCOM MMC Workstation is a dedicated workstation, which is permanently connected to the GNI to provide real time monitor, control, and MMC data processing capability to the NEXCOM System operator on the GNI and all connected RIUs, MDRs, and the next generation MMC-capable UHF radios. The A/G Router is envisioned to have its own separate MMC port and its own NIMS interface and will only interface with the NEXCOM MMC Workstation for status indication in case of a failure at the A/G Router. The NEXCOM MMC Workstation will also control the NIMS interface to configure the specific parameter set and MMC functions that will be made available to NIMS.

B.4.0 A/G Communications System Architecture

The A/G communications system is comprised of both ground and Mobile User components. It is assumed that as the A/G communications system evolves from the current system architecture (See Appendix A) to the end-state NEXCOM architecture, the Mobile User component will incorporate fully compatible and interoperable VDL Mode 3 avionics. With this in mind the discussion of the A/G communications system architecture below will focus on the ground component.

B.4.1 Sustainment System Architecture

To sustain the existing infrastructure and to facilitate the transition to NEXCOM, the transition strategy allows NEXCOM MDR transmitters and receivers, as available, to enter the analog A/G radio supply chain for both replacement and growth applications. However, the sustainment of the current A/G Communications System, while retaining the existing system architecture, does have implications on both transition activities and the NEXCOM System level requirements, particularly for the MDR subsystem.

For sustainment, MDR transmitters and receivers will be installed in existing racks using power, or other supporting infrastructure. The MDR units will include interfaces necessary to connect to the existing RCE. The MDR units will be compatible replacements for the existing analog VHF transmitters and receivers in RCAG, BUEC, RTR, RCO, and local radio installations and will operate in the 25 kHz DSB-AM mode. Figure B-2 illustrates the insertion of NEXCOM radios to sustain present A/G communications. The operation of the sustainment system will be identical to that of the current system and transparent to the users.

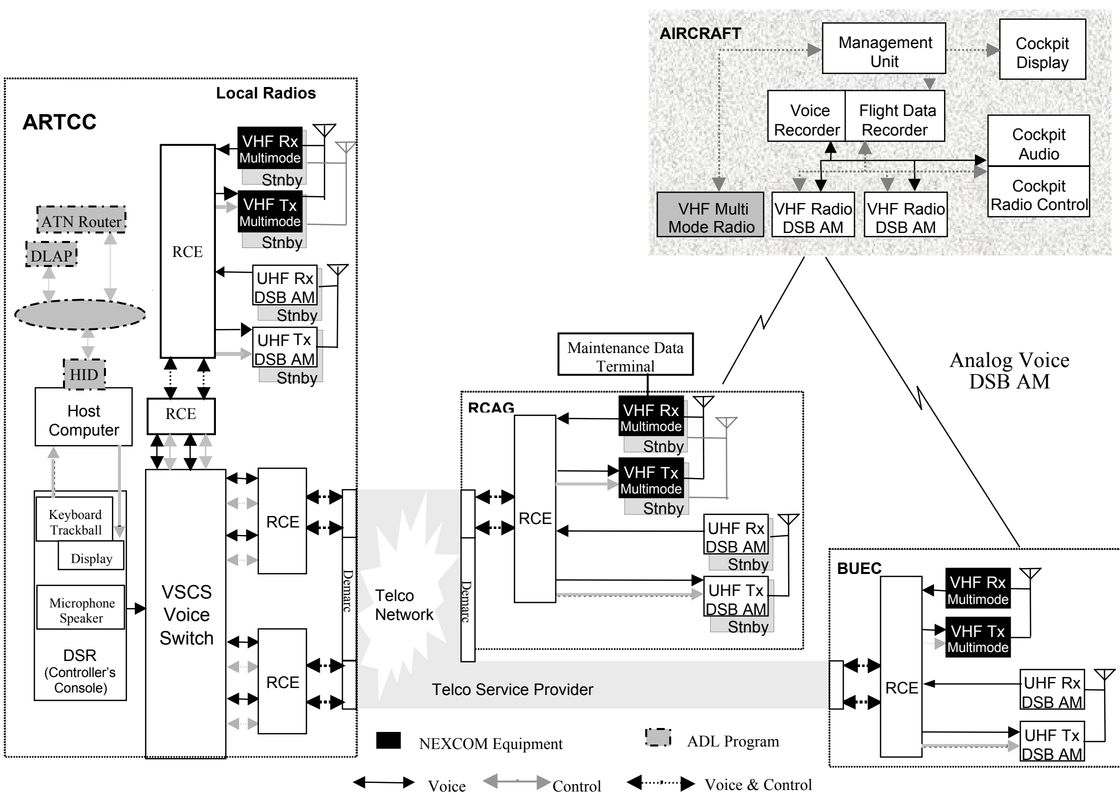


Figure B-2

Sustainment Architecture with NEXCOM MDRs (En Route)

B.4.2 NEXCOM End-State System Architecture

A functional block diagram illustrating the overall NEXCOM end-state system architecture is shown in Figure B-3 with the NEXCOM GNI, RIU, and MDR subsystems integrated with the legacy equipment for a typical En Route sector. The NEXCOM end-state is configured to provide VDL Mode 3 integrated voice and data services or to provide VDL Mode 3 digital voice only services, depending upon the specific VDL Mode 3 system configurations chosen.

MDR transmitters and receivers will be installed in existing RCFs to replace the current VHF analog radios. RIUs will be installed to replace the existing RCEs to provide the critical VDL Mode 3 link layer functionality and to provide remote monitoring and control of the MDRs and the next generation UHF radios. The GNI will be installed at the control facility to perform voice encoding/decoding, multiplexing function, and network layer functions associated with Subnetwork Access Protocol (SNAcP) and the DLS functions complementary to that of the RIU.

The current voice-grade leased lines need to be upgraded with digital links of appropriate bandwidths and characteristics for most applications. For applications with lesser bandwidth requirements current VG-6 and VG-8 voice grade lines can be used with appropriate modems for communications between the control and remote radio facilities. The existing voice switches, which provide switching function, display for channel label, generation of signaling for PTT and radio selection and passing various confirmation signals for display to the controller would require modifications to continue to provide similar functions in the VDL Mode 3 environment. In addition, certain VDL Mode 3 system features and functionality may also require modifications to some legacy equipment, e.g., change of display to allow the new channel label to be displayed, adding signaling for preemption of Mobile User voice transmission.

For VDL Mode 3 voice operation, vocoders in the GNI will provide voice encoding and decoding to reduce the bandwidth requirement for interfacility communications between the control and remote radio sites. Vocoders in the RIU will be used to convert voice between analog and digital forms for the UHF radios and for local monitoring at the radio site. The VDL Mode 3 system as depicted in Figure B-3 must also support DSB-AM voice operation by incorporating appropriate PCM voice interface between the MDR and the RIU. For the end-state, the following voice modes are supported:

a) VDL Mode 3 Voice Operation for Non-diversity Site Groups: Uplink voice from the voice switch (analog voice or PCM voice) is encoded using the VDL Mode 3 vocoder at the GNI. The encoded uplink voice is sent via the RIU to the MDR transmitter for modulation and transmission. In the RIU the uplink voice will also be converted to analog voice and sent to the UHF transmitter for modulation and uplink transmission. The downlink VDL Mode 3 voice will be decoded at the GNI, and the resultant voice signals (analog voice or PCM voice) will be sent through the voice switch to the controller. The UHF downlink analog voice from the UHF receiver is converted and encoded, using the VDL Mode 3 vocoder, at the RIU for transmission to the GNI. The encoded VHF and UHF downlink voice is decoded to either analog voice or PCM voice at the GNI, depending upon the voice interface used between the GNI and the voice switch, and sent through the voice switch to the controller.
b) VDL Mode 3 Voice Operation for Diversity Site Groups: Voice operation for diversity site groups is similar to the diversity site group voice operation of the current DSB-AM system described in Appendix A.3.2.2. There can be from 2 to 6 RCAG/BUEC facilities for up to 12 radio facilities for one large sector for all using the same time slot to support

A/G voice communications for the Talk Group. The diversity group allows an operator the ability to transmit from the selected transmitter and listen on up to 6 radio receivers on the same time slot. The operator can only key one transmitter at a time based on operator selection. To minimize potential downlink interference from multiple downlink access attempts from different Mobile Users within the diversity site group, the voice field in all the uplink M-burst transmissions will be set for "Mobile User access" for the duration of the downlink access. All receivers can be active at the same time with VSCS selecting a single downlink voice signal, based on the specific selection algorithm implemented, and present it to the operator's headset for use. In order to eliminate potential mutual interference from the uplink M-burst transmissions from multiple transmitters within the diversity site group, uplink M-burst transmissions within the diversity site group will be coordinated to ensure that only one uplink M-burst is transmitted in any MAC cycle. Furthermore, to maintain Mobile User radios in the normal timing state of TS1, a Mobile User radio needs to receive a pair of M-bursts from the same transmitter no less frequent than every 5.76 seconds. Since a Mobile User radio will transition to TS2 timing state in approximately 12 seconds without receiving a timing beacon, a beacon rotation scheme based on each transmitter transmitting a pair of beacons every 5.76 seconds (=2MAC cycles x 12 radios) should prevent Mobile Users from entering TS2 timing state.

DSB-AM Voice Operation: Uplink voice from the voice switch (analog voice or PCM voice) is encoded using a VDL Mode 3 vocoder at the GNI and sent to the RIU. The encoded uplink voice is decoded to MDR-compliant PCM voice in the RIU, and the PCM voice is converted to analog voice in the MDR transmitter for AM modulation and uplink transmission. In the RIU the uplink PCM voice will also be converted to analog voice and sent to the UHF transmitter for modulation and uplink transmission. The downlink demodulated analog voice is converted to PCM voice and sent to the RIU, where the PCM voice is encoded using a VDL Mode 3 vocoder for transmission to the GNI. The UHF downlink analog voice from the UHF receiver is converted and encoded, using the VDL Mode 3 vocoder, at the RIU for transmission to the GNI. The encoded VHF and UHF downlink voice is decoded to either analog voice or PCM voice at the GNI, depending upon the voice interface used between the GNI and the voice switch, and sent through the voice switch to the controller.

For data services, the GNI will interface with an A/G Router for connection to the automation system.

Equipment configurations for the MDR and RIU are similar to that of the analog radios and RCE of the current system in that Main/Standby radios are provided for the RCAG and no backup RIU is used at any radio site. The NEXCOM System also has the capability of auto switching between the main and standby radios operating from the same RIU in the event of a radio failure. This automatic radio switching function is not available in the current DSB-AM system and is provided to enhance the system availability. Manual selection between the main and standby radios by the controllers, available in the current system, will continue to be provided in the NEXCOM VDL Mode 3.

There are no plans at this time to implement a VDL Mode 3 like UHF solution. The next generation UHF radios will continue to use DSB-AM modulation, but will implement MMC capabilities to allow remote monitor and control functions to be performed locally at the radio and remotely from the RIU and the control site MMC Workstation and NIMS.

The NEXCOM System requires site diversity and equipment redundancy to ensure that the overall service availability objectives are met and that there is no single point of failure in the NEXCOM System. The latter is a requirement associated with critical services as defined in NAS-SR-1000, Section 3.8.1, for voice and data.

Appendix E provides detailed Reliability, Maintainability, and Availability analysis of the NEXCOM System to determine the required Mean-Time-Between-Failure (MTBF) for each of the NEXCOM Subsystems.

B.4.2.1 GNI Network Architecture

The A/G Router is the entry point to the VDL Mode 3 subnetwork in the ATN. When the data portion of the NEXCOM System is brought into service, it too must have an A/G Router. Because the ATN design requires that IDRP be initialized each time a Mobile User contacts an A/G Router (a lengthy process), the number of such routers must be kept to a reasonably small number to reduce the number of IDRP initializations required. The baseline for distributing the A/G Routers in the NAS is based on using one A/G Router in each En Route center. The baseline appears to be a good compromise between the extreme cases of a) sharing a single A/G Router for the entire NAS, and b) using one router for each control facility.

Considering that all control facilities need local access to their voice switches and the A/G Routers are available only at the En Route centers, a Terminal area GNI must, therefore, be routed to a nearby En Route center for access to an A/G Router. A GNI data switching function is proposed as part of the overall GNI hierarchy as a means to optimize the subnetwork traffic and reduce disconnect time between GNIs. The GNI data switching function may be implemented as a separate physical entity or integrated with the En Route center GNI as shown in Figure B-4. In the latter the GNI with the GNI data switch function must support routing of packets for those GNIs that do not have a GNI data switching function to access A/G Routers for data connectivity. This network hierarchy allows the radio system to transfer a Mobile User from one ground radio to another ground radio within the router's domain transparent to the router. Only when a Mobile User is handed off between facilities supported by different routers will the ATN recognize that the subnetwork connectivity has changed and apply its needed mobile routing overhead (IDRP connection). Since not all control facilities are planned to have their own A/G Router, all facilities needing A/G data services that do not have a co-located router will have their GNIs connecting to the router-equipped facilities for data connection.

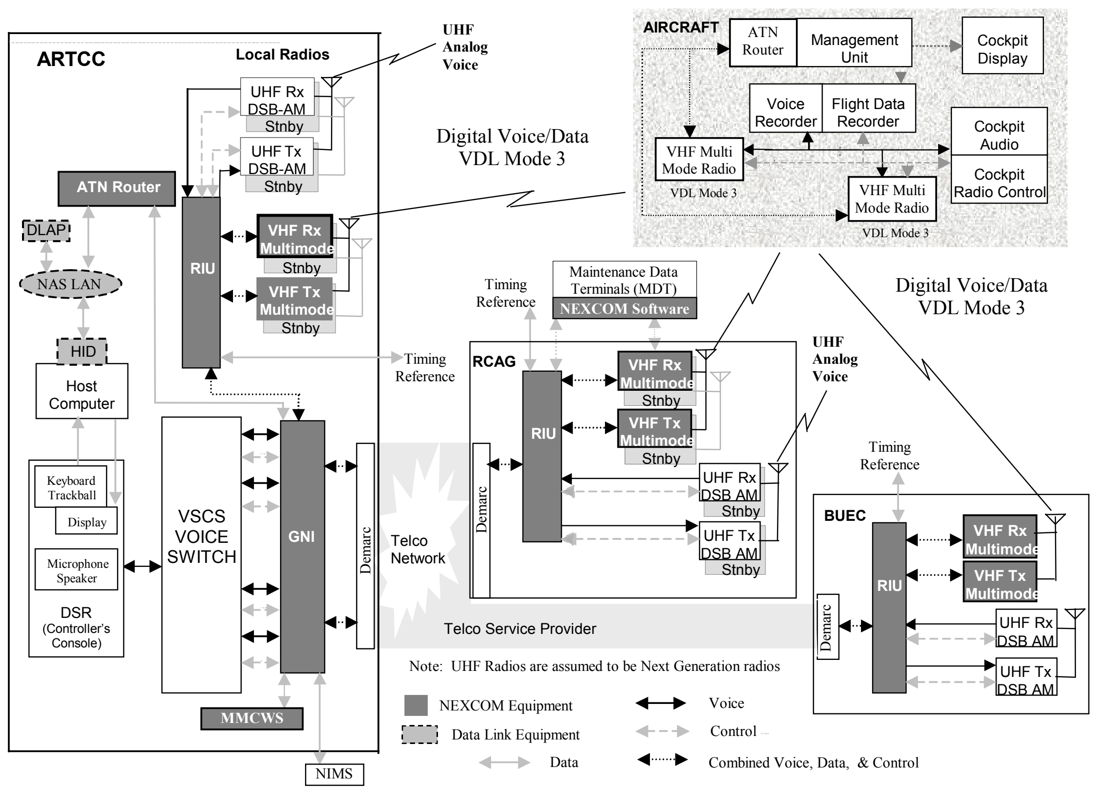
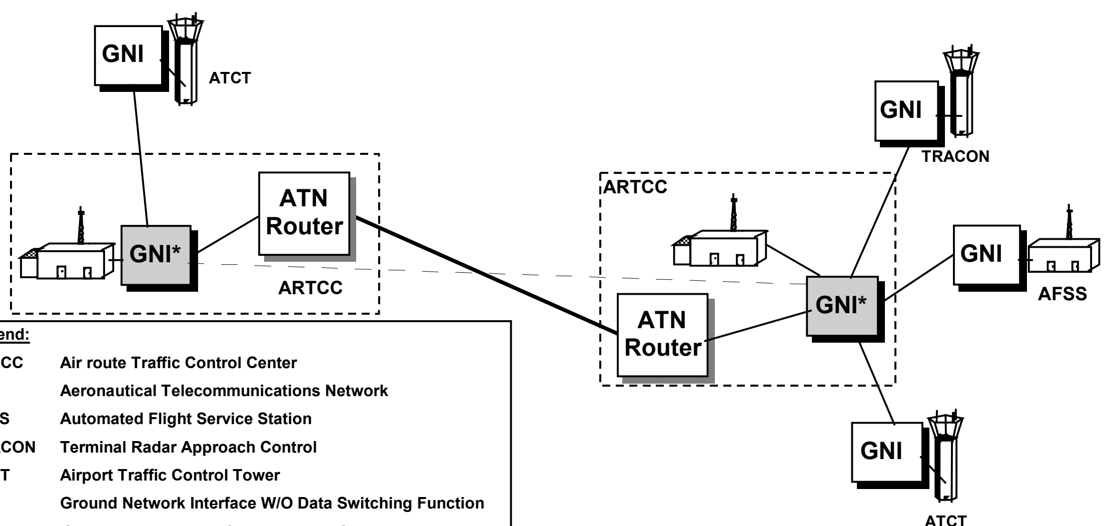


Figure B-3

End-State Architecture (En Route)



Legend:	
ARTCC	Air route Traffic Control Center
ATN	Aeronautical Telecommunications Network
AFSS	Automated Flight Service Station
TRACON	Terminal Radar Approach Control
ATCT	Airport Traffic Control Tower
GNI	Ground Network Interface W/O Data Switching Function
GNI*	Ground Network Interface with Data Switching Function

Figure B-4

GNI Hierarchy with GNI Data Switching Function at En Route GNIs

B.4.2.2 Timing System Architecture

In a multiple ground station architecture, multiple ground station radios (e.g., RCAG and BUEC) are used to support separate TDMA nets associated with the same 25 kHz channel in the VDL Mode 3 system. These ground radios would need to be time synchronized to ensure that transmission bursts from radios of different User Groups are not overlapping. One way to ensure that such radios are synchronized is to require that these ground radios are synchronized to a common external time reference. To extend this concept further, if a common time reference is available globally and all NAS ground radios are synchronized to this common time reference, then all the NAS ground radios will be time synchronized and TDMA nets in the NAS will be time synchronized. Even though the system only requires local or regional synchronization, the timing system architecture for NEXCOM is based on the use of a common external time reference for the entire NAS, because such a global time reference is readily available.

One such timing synchronization scheme is based on the RIU subsystem being synchronized to their external time source, which is in turn conditioned by a global time reference. For a small site with one or two RIUs, each RIU can interface directly to its dedicated external time source conditioned by the common time reference. For sites with a large number of RIUs, an external time source that is conditioned by its own external time reference may be used in conjunction with a time distribution system to provide multiple feeds to the collocated RIUs. Such an arrangement is illustrated in Figure B-5. Note that the external time source and the common time reference may need back up depending upon the reliability (MTBF) of the external time source and common time reference available.

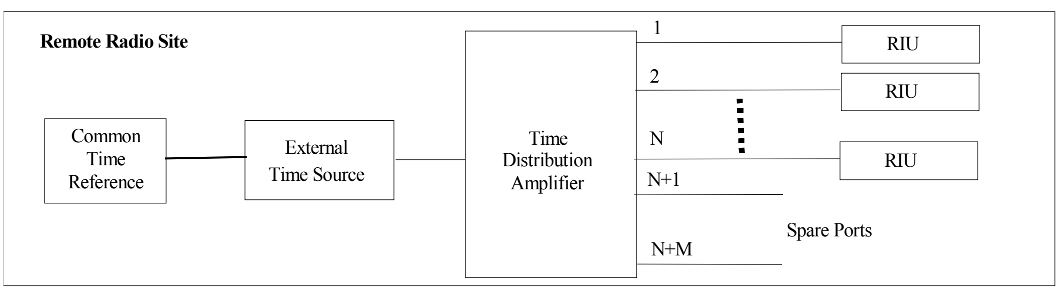


Figure B-5

Timing Distribution System Concept

B.4.2.3 MMC System Architecture

The NEXCOM MMC system is based on a hybrid control concept with central control at the GNI via the NEXCOM MMC Workstation and the NIMS Control Center, and a distributed control providing for local monitor and control at the NEXCOM Subsystem level. Central control provides the NEXCOM System operator full control of the NEXCOM Subsystems in terms of monitoring critical parameters and changing control parameters during normal operation and in supporting remote system certification, as the radio sites are unmanned. Distributed control is provided to allow maintenance personnel local control and monitoring of the radio site equipment during scheduled on-site maintenance and on site

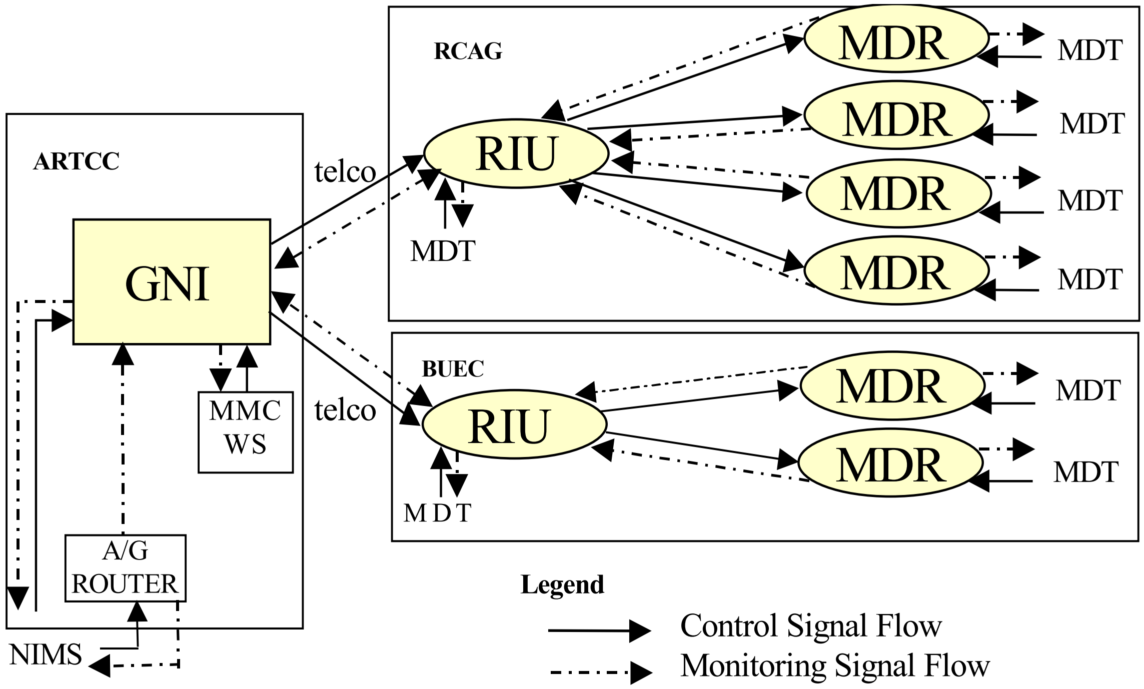
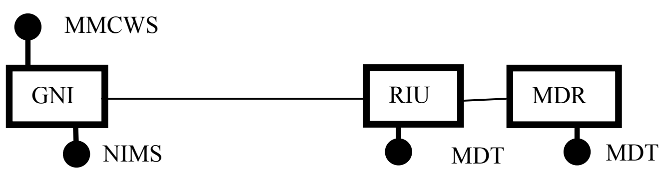


Figure B-6

NEXCOM MMC System Architecture



Access from	Access to		
	GNI	RIU	MDR
MMCWS	L(M,C)	R(M,C)	R(M,C)
NIMS	R(M,C)	R(M,C)	R(M,C)
RIU-MDT	*R(M)	L(M,C)	R(M,C)
MDR-MDT	X	X	L(M,C)

: Port
L : Local
R : Remote
M : Monitor
C : Control
X : Not Permitted

* The RIU's associated channel information

Figure B-6a

NEXCOM MMC System Hierarchy

***Note**: The NEXCOM MMC system as depicted in Figure B-6 illustrates the hierarchy of the NEXCOM MMC system in terms of monitor and control with the GNI at the top, followed by the RIU, and MDR in that order. The NEXCOM MMC Workstation also has capability to monitor the operation/failure status of the A/G Router. The A/G Router also interfaces directly with NIMS.*

diagnostics/troubleshooting. Central MMC functions can be performed from the GNI via the NEXCOM MMC Workstation. Distributed MMC functions are provided locally at the remote radio site RIU and MDR subsystems. Access to the NEXCOM MMC system will be via the standard NIMS MDT with the NEXCOM MDT software. A NEXCOM MMC Workstation is permanently set up to provide the NEXCOM System operator full MMC access at the GNI. The MMC Workstation is loaded with NEXCOM MMC software designed to meet the NEXCOM MMC requirements.

The NEXCOM MMC system architecture used to support this hybrid system concept is shown in Figure B-6 with each MDR connected in series with its RIU and GNI. Figure B-6 also shows the MMC architecture with the MMC signal flow for the NEXCOM end-state system.

The NEXCOM MMC system control hierarchy follows the following general rules:
a) Higher level element has control over lower level elements,
b) Lower level elements do not control higher level elements,
c) Elements at the same level do not control each other.

The NEXCOM MMC system monitoring hierarchy follows the following general rules:
a) Higher level element monitors the lower level elements,
b) Lower level elements do not monitor higher level elements,
c) Elements at the same level do not monitor each other

Exceptions to the general rules above include the following:
a) An RIU can monitor, through the GNI, its associated diversity site RIU/MDRs. However, it cannot control the associated diversity RIU/MDRs.
b) An RIU can monitor, but not control, the GNI associated with that particular channel assignment.

On-site maintenance personnel also have the capacity to control equal or higher level elements of the NEXCOM System through NIMS by using the dial up capability of the MDT for connection to NIMS, provided that the on-site personnel have the proper privilege and authorization.

The GNI acts as the NEXCOM MMC concentrator. The GNI provides a single NEXCOM System interface to NIMS. This interface is capable of passing all available NEXCOM MMC information to NIMS. The GNI will be designed to limit the set of parameters and the type of MMC functions that the NIMS will be able to perform through configuration control from the NEXCOM MMC Workstation. The GNI will be implemented as NIMS proxy agent with NIMS compliant SNMP. No direct NIMS interfaces are provided at the RIU and MDR as such direct interfaces to NIMS at RIU and MDR are deemed unnecessary and not economically justifiable.

B.4.2.4 Information System Security (ISS) Architecture

ISS Architectures will be developed for proposed solutions that will meet the following security goals:
a) Reduce security risks to the NAS

b) Provide sufficient guarantee that NEXCOM Service can be maintained during an information security (INFOSEC) intrusion – accidental or intended

Figure B-7 provides sufficient detail to outline interfaces between NEXCOM Components and NAS Components interfacing to NEXCOM.

The information that follows describes the interfaces between NAS components and NEXCOM components. As network security requirements are dependent on the interface communication protocols used and the peer entities using the interface, the following information is useful in determining these requirements. The information presented consists of an interface diagram (Figure B-7), and supporting Table B-1. Together, they describe currently known interfaces to NEXCOM components with an explanation of the interface's purpose and the communication protocols that will probably be used for the interface. The diagram and supporting text may not be complete and are not authoritative. They are provided for illustrative purposes only. The following notes apply to the diagram.

a) Routers, whose only function is to move LAN IP data to/from WAN, are not shown. (The A/G Router does more than this and is shown.
b) Firewalls are not shown, as their exact placement and functionality cannot be known until the security requirements are determined. The NEXCOM program may be responsible for the implementation of firewall functionality or this functionality may be provided by an installed, facility level NAS CNSM.
c) The NEXCOM security perimeters are shown on the diagram. The FAA, or another organization (public or private) may operate equipment outside the perimeter. With respect to FAA equipment, the perimeter separates existing NAS components, whose INFOSEC security requirements and procedures already exist, from new NEXCOM equipment, whose INFOSEC requirements must be determined
d) All NEXCOM interfaces that cross the security perimeter have been numbered, as have all communication interfaces between NEXCOM equipment. The peer entities using these interfaces and the protocols used (as known to date) appear in the table.
e) Between any two NEXCOM components only 1 interface is shown. The implementation may be such that multiple physical interfaces are used. If the interface has multiple purposes, the accompanying table lists each.
f) The diagram contains examples of possible variants in the placement of NEXCOM components. The fact that the TRACON/ATCT site is connected to a separated radio site does not mean that all TRACONs have separated radio sites. The placement of A/G Routers has not been determined. What is known at this time is that there will be a limited number of sites with A/G Routers, and the majority of sites will not have A/G Routers. Hence, two sites (and their relationship) are depicted in the diagram to illustrate the two possible interactions with an A/G Router.
g) For the purposes of the table, local means within the same physically protected site, and remote means located at a site different from the subject component site.
h) The box labeled GNI may contain multiple instantiations of GNIs, as multiple boards on a platform or as a networked complex of platforms. For any such installation there will be only one interface to the HID/NAS LAN and only one interface to the A/G Router. That is, only one GNI will control the interface. This GNI will relay data between interfaces and all other GNI subsystems in the installation.

i) A GNI (or an installation of GNI subsystems, see above) will be connected to more than one RIU. The diagram represents this in only one instance, depicting a GNI that is located within an ARTCC connected to multiple radio sites.
j) The term 'control' is used in two senses in the table. Radio control refers to the necessary actions, protocols, etc., which allow the controller to switch sites, begin transmitting, etc. The control in monitor, maintenance and control (MMC) refers to the ability to modify pre-defined system parameters on the subject platform.

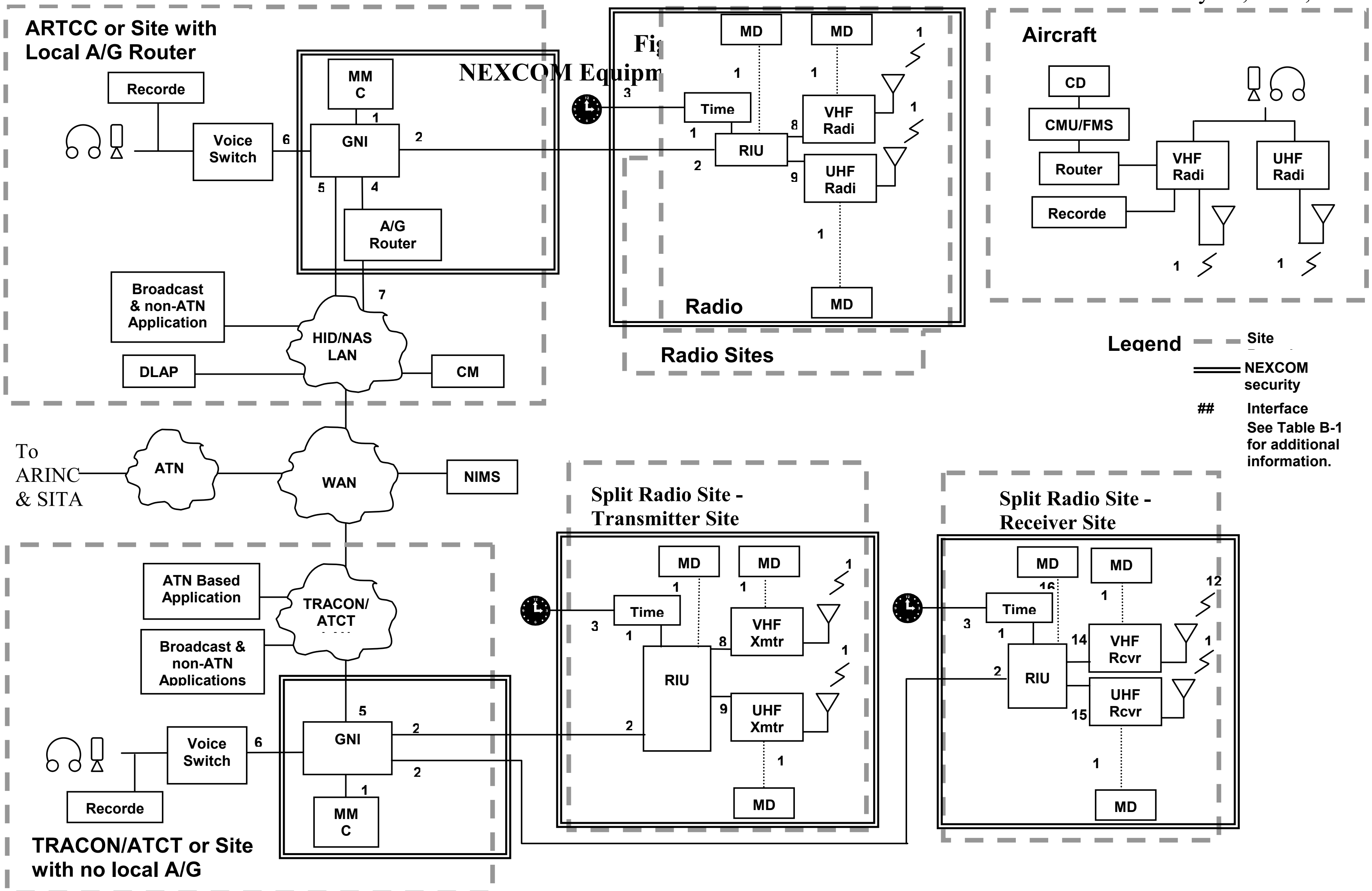
Table B-1

NEXCOM Interfaces: Purpose, Peers and Protocols

Interface Number	Interface Peers	Information Transferred	Protocol	Comments
1	MMC Work Station – GNI	Maintenance, Monitor and Control (MMC) information	Vendor Supplied	Workstation assumed to be directly attached to GNI and physically secured.
				NEXCOM components can be managed remotely via NIMS also
2	GNI – RIU	Digitized Voice	TBD	Presumably communications supplied by FTI for radio sites remote from GNI.
		Radio Control (controller directives)	TBD	Same comment as above
		Data	TBD	Same comment as above
		Remote MMC for Radio and RIU	TBD	Same comment as above; GNI relays all NIMS requests for RIU and radio status
3	NEXCOM Regional Time Synchronization Source – Local RIU Time Source	Time coordination parameters	TBD	Origin of regional-wide time synchronization yet to be determined.
4	GNI – NEXCOM Air/Ground (A/G) Router	A/G Router initiation control	ISH, Join & leave messages over vendor supplied link protocol	Local A/G Router required to connect VDL Mode 3 to ATN
		Aircraft router updates	IDRP over vendor supplied link protocol	Use of IDRP causes extended initiation time. Therefore, goal is to have each A/G Router cover as large an area as possible. Hence, not all sites have an A/G Router. (*cf.* Interface 5)
		CLNP packets to/from aircraft	CLNP over vendor supplied link protocol	CPDLC and Context Management (CM) are applications which use CLNP

Interface Number	Interface Peers	Information Transferred	Protocol	Comments
5	GNI – NIMS	Remote MMC	SNMPV3 with encryption over IP Suite	NIMS defines interface protocol used
	GNI – GNI communications	VDL Mode 3 data frames, State information	Vendor supplied over IP Suite	Supports Make-before-Break
		VDL Mode 3 data frames, State information, and ATN Join/Leave messages	Vendor supplied over IP Suite	Provides data link connection for sites without a collocated A/G Router
	GNI to local broadcast and non-ATN application processor(s)	Application data to/from aircraft under site control	IP Suite	Application and supporting program yet to be defined
6	GNI – Voice Switch	Controller/Pilot voice (analog and/or digital)	Discrete inputs	In future this may be a T1 line
		Radio control information (e.g., switch among broadcast sites)	Discrete inputs	In future this may be a T1 line
7	NEXCOM A/G ATN Router – local DLAP/CM	CPDLC, CM, and ATN Router discovery data	ES-IS and CLNP over FAA defined LAN protocol	Protocol (LAN and WAN) between CLNP machines determined by CPDLC program
	A/G Router – ATN Backbone	ATN routing protocols (IS-IS, IDRP)	CLNP over FAA defined LAN protocol	Protocol (LAN and WAN) between CLNP machines determined by CPDLC program
		Aircraft application traffic to/from other sites	CLNP over FAA defined LAN protocol	Protocol (LAN and WAN) between CLNP machines determined by CPDLC program
	NEXCOM A/G Router – NIMS server	Remote MMC	SNMPV3 with encryption over IP Suite	NIMS defines interface protocol used
8	RIU – Local VHF Radio or local VHF transmitter	Controller/pilot voice; Radio control information; MMC; CPDLC & CM data	Fractional T1 RIU protocol	Security requirements may differ between local and remote cases
9	RIU – Local UHF Radio or local UHF transmitter	Voice	Analog voice	Security requirements may differ between local and remote cases
		Radio Control; MMC	Digital	Same comment as above
10	RIU – Time Source	Time reference protocol	Discrete l pps and Time Of Day inputs	
11	MDT – VHF MDR	Local MMC	Vendor supplied (RS-232 based)	Security requirements already specified in MDR Specification

Interface Number	Interface Peers	Information Transferred	Protocol	Comments
12	VHF radio – Mobile user VHF radio	VDL Mode 3 Network management	As specified in RTCA DO-224A	Ground may set or read control information (XID exchange)
		Controller/pilot voice	As specified in RTCA DO-224A	
		CPDLC, CM data	ATN	Application traffic transparent to VDL Mode 3
13	UHF Radio – Mobile user UHF radio	Controller/pilot voice	Analog	
14	RIU – Remote VHF receiver	Controller/pilot voice; Radio control information; MMC; CPDLC & CM data	Same as interface 8	FTI supplied communications at some sites
15	RIU – Remote UHF receiver	Voice; MMC; Radio Control	Same as interface 9	FTI supplied communications as some sites
16	RIU – MDT	MMC	Vendor supplied	Probably same requirements as interface 11
17	MDT – UHF Radio	MMC	Vendor Supplied (RS232 based)	Security requirements specified in VHF MDR may suffice


ARTCC or Site with Local A/G Router
Recorde
Voice Switch
MM C
GNI
A/G Router
Broadcast & non-ATN Application
HID/NAS LAN
DLAP
CM
NEXCOM Equipm
Fi
MD
MD
Time
RIU
VHF Radi
UHF Radi
MD
Radio
Radio Sites
Aircraft
CD
CMU/FMS
Router
VHF Radi
UHF Radi
Recorde
Legend
Site
NEXCOM security
Interface
See Table B-1 for additional information.
To ARINC & SITA
ATN
WAN
NIMS
Split Radio Site - Transmitter Site
MD
MD
Time
RIU
VHF Xmtr
UHF Xmtr
MD
Split Radio Site - Receiver Site
MD
MD
Time
RIU
VHF Rcvr
UHF Rcvr
MD
ATN Based Application
TRACON/ ATCT
Broadcast & non-ATN Applications
Voice Switch
GNI
MM C
Recorde
TRACON/ATCT or Site with no local A/G

B.4.2.5 Separated Transmitter/Receiver System Architecture

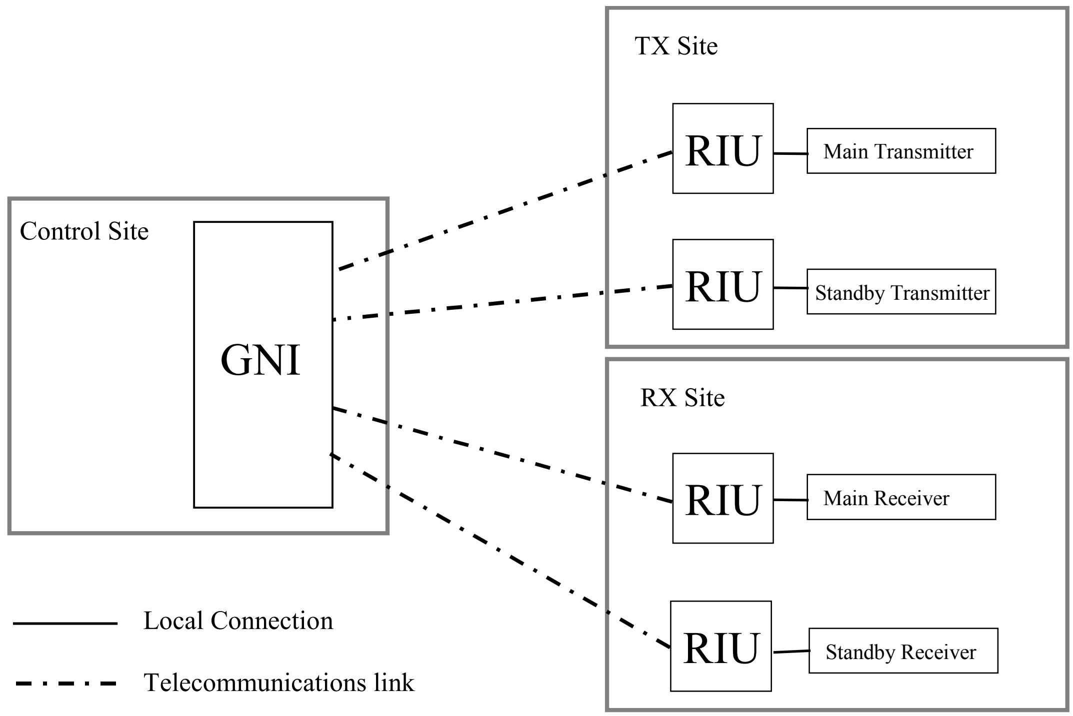
For site configurations used by the NEXCOM System, the baseline end-state system architecture depicted in Figure B-3 for the En Route domain applies, except in the case of the Separated Transmitter/Receiver (STR) configuration, which is common in the Terminal environment. For STR sites, connectivity requirements between the receive site and the RIUs at the transmit site could pose severe telecommunications link requirements to the NEXCOM System, from both a bandwidth requirement and the number of circuits that may be required. Cost aside, one of the major concerns is that wideband digital telecommunications links may not be readily available for all the STR sites. Therefore for STR sites, additional RIUs can be collocated with the MDR and UHF receivers at the receive site. This will allow the standard RIU/telecommunications link interface to be used to connect the receivers to the GNI, as a means to reduce the overall telecommunications requirements for the STR system. Note that in this architecture the receiver and its transmitter are operating off different RIUs, which is no different from using the RCAG for transmission and BUEC for receiving in Figure B-3 for the baseline system architecture. STR architecture is illustrated in Figure B-7 and Figure B-8. In reality, the transmitter or its receiver may be separately located, with up to 4 local STR sites. For simplicity, only the portion that is different from the baseline architecture of Figure B-3 is shown in Figure B-8. The telecommunications link requirement between the RIU and GNI normally can be handled with a 56 kbps digital link or by a number of VG-6 lines for sites with no digital telecommunications connectivity. The GNI will be implemented such that any transmitter can be paired with any receiver.Telecommunications Link Configuration

B.4.2.6 Telecommunications Link Configuration

Telecommunications links are required to provide communications between GNI in a control site to RIUs in remote radio sites. This link may consist of a single digital circuit with sufficient bandwidth or multiple voice grade circuits. For example, multiple VG-6 lines or a single 56 kbps digital circuit may be used to support the full communications capability between a RIU and its GNI. For split transmitter and receiver sites, the RIU is collocated with the transmitter and, as an option, a second RIU will be installed at the receive site to interface with the MDR and UHF radios. Separate telecommunications links are required to connect the transmit site RIU and the receiver site RIU to their associated GNI(s) at the control site. This configuration is depicted in Figure B-8. For communications between RIU and GNI it is envisioned that backup telecommunications links may be desirable for certain installations to improve the overall service availability. In the NEXCOM System three levels of redundancy are assumed for the telecommunications link between the GNI and a RIU:

a) No backup
b) Standby telecommunications backup
c) Hot telecommunications backup

In the case of No Backup, the telecommunications link is single-threaded. Failure of the telecommunications link will cause interruption in the GNI-RIU communications and would require the Telecommunications Link service provider to restore the link. The NEXCOM System must restore its service by using a separate GNI RIU connection until the failed link is restored. In the case of Standby Telecommunications Backup, two telecommunications links will be connected between a RIU and its GNI, one designated as primary and the other as backup. Only the primary link will be connected to pass data between the RIU and GNI. When the primary telecommunications link fails, the GNI and RIU can be commanded to restore operation using the backup link. Typically, the primary and backup telecommunications links are based on dissimilar communications links with different performance characteristics, e.g., delay and availability. Since a backup link is typically less reliable than its primary, switch back to the primary link is normally performed upon restoration of the primary link. The switching from the primary to the backup link is selectable to be automatic or manual. In the automatic mode, when the primary link fails the GNI and RIU independently detect the link failure and switch to the backup link automatically and independently. In the manual mode, detection of the link failure will be performed as in the case of the automatic mode but will not cause switching of the telecommunications link automatically. The detection of link failure will cause system alarms to be generated and forwarded to the MMC system. The MMC system will be used to switch manually from the failed link to its backup link with appropriate MMC commands. The switchback from the backup link to the primary link is also selectable to be either automatic or manual. In the case of automatic switchback, the GNI will coordinate with the RIU over the backup link for the switching to ensure that no loss of data will result from the switching. Switchback in the manual mode will be performed by manual entry of commands through the MMC system. In the case of Hot Backup, two telecommunications links will be connected between a RIU and GNI. Both telecommunications link in a hot backup configuration pass data between the RIU and GNI to ensure that failure to either one link will not interrupt communications between the GNI and RIU. This might require that data received on both lines be fully processed by the GNI and RIU. A failure to either one of the two links must not result in any performance degradation. There should not be any loss of data due to the failure of one of the two links. Communications between the GNI and RIU will be interrupted only when both links fail. The two telecommunications links in a hot backup configuration can be dissimilar in their characteristics, e.g., delay and availability, but the performance of each link must meet minimum performance requirements appropriate to the service it carries. If there are different delays between the two links, equalization within NEXCOM components may be required. The difference in delay characteristics should not cause any loss of data between the RIU and GNI when either link fails.



***Note**: In Figure B -8 each receiver and each transmitter is operating with different RIUs.*

Figure B-8

End-State Architecture for STR Sites

B.5.0 NEXCOM Concept of Use

Currently being defined by RTCA SC-198.

APPENDIX C

Nexcom Security Requirements

C.1.0 INTRODUCTION

C.1.1 Purpose

This appendix is non-normative and provides policy driven high level requirements from which the SRD security requirements were derived.

The NEXCOM Minimum Security Requirements represents fundamental guidance to the NEXCOM system design. This ensures that National and FAA Information System Security (ISS) requirements are satisfied. System-level ISS requirements are integral components of the functional and performance Subsystem Specifications (SSS) and interface documents that will be developed as a result of this document.

NEXCOM is a system that resides within the National Airspace System (NAS), which has been specifically designated a key element of the Critical National Infrastructure. Accordingly, all NAS information systems, including NEXCOM must provide satisfactory levels of system and data availability and integrity and, for explicitly designated categories of information, confidentiality protections.

C.1.2 Scope

The NEXCOM Minimum Security Requirements are applicable to all components within the NEXCOM System.

C.2.0 NEXCOM MINIMUM SECURITY REQUIREMENTS

C.2.1 Platform Security

Table C-1 below defines a standard set of fifteen policy-based security requirements applicable to almost all NAS platforms with minor exceptions. Fourteen of these “shall statements” represent the mandated minimum protection level for the NAS required by FAA Order 1370.82. The last shall statement provides an additional standard FAA requirement for a monitor screen "Logon Warning Banner." These requirements comprise a basic default set of security shall statements, which is allocated intact to every NAS information system host platform meeting the following criteria:

a) The platform creates, processes, stores and/or sends NAS operational information or data within the meaning of FAA Order 1370.82;
b) The platform has a human/machine interface;
c) The platform is connected to a data network.

Table C-1

Policy-driven NAS ISS Requirements for Platforms

Requirement Number	Policy-Driven Requirement
P-1	The subsystem **shall** be capable of assigning a unique identifier to each authenticated user.
P-2	The subsystem **shall** be capable of assigning a unique identifier to each subsystem process, including those not running on behalf of a human user.
P-3	The subsystem **shall** be capable of authenticating the claimed user's identity before allowing any user to perform any actions other than a well-defined set of operations (e.g., reading from a public web site).
P-4	The subsystem **shall** be capable of executing a defined access control policy.
P-5	The subsystem **shall** be capable of enabling access authorization management; i.e., the initialization, assignment, and modification of access rights (e.g. read, write, execute) to data objects with respect to (1) active entity name or group membership; and (2) such constraints as time-of-day and port-of-entry.
P-6	The subsystem **shall** be capable of auditing in support of individual accountability and detection of and response to insecurity.
P-7	The subsystem **shall** provide mechanisms for detecting insecurities, designated "Security Relevant Events."
P-8	The subsystem **shall** protect audit logs against deletion and modification, even by subsystem security administrators.
P-9	The subsystem **shall** be capable of providing resource allocation features having a measure of resistance to resource depletion.
P-10	The subsystem **shall** be capable of detecting and removing malicious code and data (e.g., viruses, and worms).
P-11	The subsystem **shall** automatically suspend user accounts after an adaptable number of failed logon attempts.
P-12	The subsystem **shall** automatically force a user logoff after an adaptable number of minutes of inactivity and send an alert message to the administrator.
P-13	The subsystem **shall** be capable of identifying network users (e.g., humans, devices and processes).
P-14	The subsystem **shall** be capable of authenticating network users (e.g., humans, devices and processes).
P-15	The subsystem **shall** display the standard FAA "Logon Warning Banner" at logon.

C.2.2 Network Security

Wide Area Network (WAN) interfaces supporting NEXCOM demonstration, sustaining and end-state configurations **shall** implement requirements for integrity, availability and (where applicable) confidentiality services. The Common Network Security Model (CNSM) described in Section 3.3 of FAA Information Systems Security Architecture (ISSA), version 1.1, September 30, 2000 provides a standard set of NAS "boundary protection" security services. This reference allocates boundary protection requirements to all NAS facilities in the approximate timeframe of 2005-2008. The CNSM should be considered as a model for NEXCOM implementation. As a NAS component, the CNSM itself is protected by the default set of fifteen policy-driven requirements defined in Section 2.1 above.

NAS boundary protection is a logical architectural concept, which may be implemented as standalone hardware components or as security software resident on already-available front-end machines. Boundary protection functionality may be divided among a number of devices managing a facility's WAN interface. All forward and return information and data exchanged by NEXCOM components with remote processors external to their home facility transits the facility's local CNSM. Each deployed CNSM provides the following boundary protection services:

a) VPN support (if applicable) for the CNSM's facility subsystems (including NEXCOM) exchanging sensitive data across untrusted WAN segments. Tunneling provided by data encryption is required as a part of this VPN functionality.
b) Network access control mechanisms, which permit or deny external processes access to facility subsystems (including NEXCOM), based on strongly authenticated device and process identification and controlled access protection logic. This security function may be combined with screening mechanisms (e.g., firewalls) and a capability for intrusion detection and alarmed response.
c) Data confidentiality services that control the transmission of certain classes of sensitive data, for which disclosure must be controlled.
d) Strong authentication capabilities for external individuals, devices and processes requesting services
e) Virus and other malicious software detection and removal (as available)
f) Self-protection of its own platform environment using the default set of fifteen security requirements, routinely allocated to all NAS platforms.

APPENDIX D

Requirements Traceability Matrix

The traceability matrix in Table D-1 shows the source document or organization for the requirements contained in this SRD.

Table D-1

Requirements Traceability Matrix

SRD Section	SRD Title	Requirements	Source Document
3.2.1.1.1	Site Configurations	a) The NEXCOM System shall support the following site configurations: 1. Single Remote Communications Facility (RCF) 2. Separated transmitter/receiver sites 3. Primary RCF with backup site (e.g., BUEC) 4. Diversity site group (e.g., multiple RCFs for a User Group) 5. Dual control	RD Section: 4; 10.2
3.2.1.1.2	NAS ATC Facility Compatibility	a) The NEXCOM System shall operate within existing NAS ATS facilities.	RD Section: 3.2.15.1; 4.5.1; 8.8.2.1; 10.2.1.2
3.2.1.2.1	Coexistence with the Present System	a) All NEXCOM modes specified in Section 3.2.2a. shall coexist with the current VHF/UHF DSB-AM system throughout the NAS.	RD Section 10.4.1
3.2.1.2.2	Coexistence Among NEXCOM Modes of Operation	a) All NEXCOM modes specified in Section 3.2.2.a. shall coexist with all NEXCOM modes throughout the NAS.	RD Section: 10.3.1; 10.4.1
3.2.1.2.3	Coexistence with other Existing Systems	a) The NEXCOM System shall coexist with any existing FAA systems.	RD Section: 10.4.1
3.2.2	Modes of Operation	a) The NEXCOM System shall operate in each of the following selectable modes: 1. VDL Mode 3 2. 25 kHz DSB-AM 3. 8.33 kHz DSB-AM	RD Section: 3.2.12.1; 2.1; 5.3.2; 10.3.1
3.2.2	Modes of Operation	b) The NEXCOM System shall operate a UHF DSB-AM mode simultaneously with VHF modes in each User Group as needed.	RD Section: 3.1.8.1

SRD Section	SRD Title	Requirements	Source Document
3.2.2	Modes of Operation	c) The NEXCOM System shall meet United States regulatory functional requirements specified in (Part 2 and 87) and NTIA (Chapters II, V, VII, X, and ANNEX B).	(Part 2 and 87), NTIA (Chapters II, V, VII, X, and ANNEX B)
3.2.2.1	VDL Mode 3 Standardization	a) The NEXCOM System shall meet the VDL Mode 3 functional requirements for ground systems specified in RTCA DO-224A.	RD Section: 3.2.12.1; 3.2.13.2; RTCA DO-224A
3.2.2.2	25 kHz DSB-AM Standardization	a) The NEXCOM System shall meet the 25 kHz DSB-AM functional requirements specified in FAA-P-2883 and FAA-P-2884.	RD Section: 3.2.13.2; FAA-P-2883; FAA-P-2884
3.2.2.3	8.33 kHz DSB-AM Standardization	a) The NEXCOM System shall meet the 8.33 kHz DSB-AM functional requirements specified in ICAO Annex 10 and ETSI specification EN-300-676.	RD Section: 3.2.13.2; 5.4.1; ICAO Annex 10 and ETSI specification EN-300-676
3.2.2.4	Channel Labeling	a) The NEXCOM System shall operate with the ICAO channel labeling for each of the modes identified in Section 3.2.2.a.	RD Section: 3.2.13.2; SRD Section: 3.2.2.a
3.2.3.1	Voice Communications Requirements	a) The NEXCOM System shall allow all users in a Talk Group to monitor all voice communications within that Talk Group.	RD Section: 3.1.1.2; 3.1.1.3; 3.1.5.1
3.2.3.1	Voice Communications Requirements	b) Data communications, including data communications overloading, shall not prevent the operation of voice communication.	RD Section: 7.2.1; 7.3.1.1
3.2.3.1	Voice Communications Requirements	c) The NEXCOM System shall route received audio to the NEXCOM/VSCE interface based on the received audio at the remote site.	ICAO Annex 10 and ETSI specification EN-300-676
3.2.3.1.1	Voice Channels	a) The NEXCOM System shall interface with existing VSCE (e.g., VSCS, ETVS, ICSS, RDVS, STVS) via existing interfaces (e.g., Single channel VHF + UHF (V+U) and quad channel VHF/UHF/MAIN/STANDBY (V/U/M/S)).	FAA-E-2885
3.2.3.1.2	Voice Encoding/Decoding	a) The NEXCOM System/VSCE interface shall include: 1. Analog voice 2. Digital voice	RD Section: 10.2; 3.1.1.4 Note; 3.1.5.1 Note
3.2.3.1.2	Voice Encoding/Decoding	b) Voice encoding/decoding for VDL Mode 3 shall be in accordance with the vocoder algorithm specified in ICAO Annex 10, Vol. III, Part 1, Chapter 6.	RTCA DO-224A Section: 3.3.5.2.1; ICAO Annex 10, Vol. III, Part 1, Chapter 6
3.2.3.1.3.1	Uplink Path	a) The NEXCOM System shall transmit uplink voice out of the radio at the site(s) selected by the controller.	RD Section: 3.1.1.1
3.2.3.1.3.2	Downlink Path	a) The NEXCOM System shall route all downlink voice output from all selected receivers to the VSCE.	RD Section: 3.1.1.1

SRD Section	SRD Title	Requirements	Source Document
3.2.3.1.3.2.1	Local Audio Monitoring	a) The NEXCOM System shall present, in an analog format for local monitoring at the remote site, the downlink voice received at the remote site.	FAA-P-2884
3.2.3.1.3.2.1	Local Audio Monitoring	b) The NEXCOM System shall present, in an analog format for local monitoring at the remote site, the uplink voice received at the remote site.	FAA-P-2884
3.2.3.1.3.2.1	Local Audio Monitoring	c) The NEXCOM System shall present, in an analog format for local monitoring at the control site, the downlink voice received at the control site.	FAA-E-2885
3.2.3.1.3.2.1	Local Audio Monitoring	d) The NEXCOM System shall present, in an analog format for local monitoring at the control site, the uplink voice received at the control site.	FAA-E-2885
3.2.3.2.1	Data Service	a) The NEXCOM System shall provide for a subnetwork for two-way addressed data communications between ground and Mobile User systems.	RD Section: 3.1.9.1; Attachment 2 par.2 Data Communications
3.2.3.2.1	Data Service	b) The NEXCOM System shall provide for uplink broadcast using the same subnetwork as the two-way addressed service.	RD Section: 3.1.9.1; Attachment 2 par.2 Data Communications
3.2.3.2.1	Data Service	c) The NEXCOM System shall provide for uplink data broadcasts that do not depend on any information received over two-way addressed services.	RD Section: Attachment 2
3.2.3.2.1	Data Service	d) The NEXCOM System shall provide Air/Ground routing consistent with ICAO Annex 10 and ICAO Doc 9705 (Edition 3).	ICAO Annex 10 and ICAO Doc 9705 (Edition 3)
3.2.3.2.1.1	ATN Compatibility	a) The NEXCOM System shall interoperate with ATN-based Air/Ground Routers and avionics routers as defined in the ICAO Annex 10, and ICAO Doc 9705 (Edition 3).	RD Section: 3.2.17.1; Attachment 2 par. 7 ATN Compatibility; ICAO Annex 10; ICAO Doc 9705 (Edition 3)
3.2.3.2.1.2	Make-before-Break Support	a) The NEXCOM System shall support Make-before-Break (MbB) capabilities as described in RTCA DO-224A, Section 3.3.3.3.	SRD Section: 3.2.2.1; RTCA DO-224A Section: 3.3.3.3
3.2.3.2.1.3	User Authentication	a) The NEXCOM System shall support authentication of user attempts to initialize connections per RTCA DO-224A, Section 3.3.2.3.2.8.	RD Section: 7.2.1; 7.3.1.1
3.2.3.2.1.3	User Authentication	b) The NEXCOM System shall deny access to unauthorized parts of the NAS interfacing to the NEXCOM System.	RD Section: 7.2.1; 7.3.1.1; Att 2, par 13 Information Security

SRD Section	SRD Title	Requirements	Source Document
3.2.3.3	Continuous Broadcast	a) The NEXCOM System shall provide continuous ground-to-air broadcast within a service volume for the modes identified in Section 3.2.2.	RD Section: 3.1.3.1; SRD Section 3.2.2
3.2.3.4.1	Entry Into a Talk Group	a) The NEXCOM System shall allow any Mobile User operating in the correct mode entry into any Talk Group within the Talk Group's service volume.	RD Section: 3.1.1.3; 3.1.2.1
3.2.3.4.2	Automated Transfer of Communication	a) The NEXCOM System shall upload channel assignment information to a Mobile User system via the VDL Mode 3 Next Net capability defined in RTCA DO-224A.	RD Section: Attachment 2 par. 12; RTCA DO-224A Section: 3.3.2.1.4.3.3
3.2.3.4.3	Subnetwork Connectivity Reporting	a) The NEXCOM System shall report to the A/G Router only those connectivity changes to the subnetwork that affect the A/G Router connectivity decisions.	ICAO Doc 9705
3.2.3.5	Ground Station Operations	a) The NEXCOM System shall support diversity site group(s) operation (See Appendix A for DSB-AM and Appendix B for VDL Mode 3).	RD Section: 3.2.10.1; 3.2.15.1; 3.10.2.1; 3.10.4.1; SRD Section: App A
3.2.3.5	Ground Station Operations	b) The NEXCOM System shall schedule the VDL Mode 3 uplink M-Burst of the ground transmitters to avoid self-interference.	SRD Section: 3.2.2.1
3.2.3.5	Ground Station Operations	c) In any User Group, the active transmitter shall not cause harmful interference with any other User Group operating on the same frequency.	RD Section: 10.3.1; 10.4.1; SRD Section: 3.2.2.1
3.2.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	a) The NEXCOM System voice channel uplink access shall be based on PTT assertion.	RD Section: 3.1.4.1
3.2.3.6.2	PTT/PTT Release Confirmation	a) The NEXCOM System shall provide confirmation of PTT/PTT Release on a per Talk Group basis.	RD Section: 3.1.1.4; 3.1.7.1
3.2.3.6.2	PTT/PTT Release Confirmation	b) The NEXCOM System shall be configurable to provide confirmation of PTT/PTT Release based on the reception of the transmitted signal.	RD Section: 3.1.1.4; 3.1.7.1
3.2.3.6.3	Preemption of Mobile Users' Voice Transmissions (Controller Override)	a) The NEXCOM System shall provide a selectable function that allows the controller to preempt Mobile Users' voice transmissions on a per Talk Group basis as follows. 1. Preemption Off (Function disabled) 2. Preemption On (Upon PTT activation preemption occurs) 3. Momentary Preemption on a single PTT basis (Dynamic function selectable by the controller)	RD Section: 3.3.1; 3.3.2; RTCA DO-224A Section: 3.3.2.1.1.1

SRD Section	SRD Title	Requirements	Source Document
3.2.3.6.4	Preemption Confirmation of Mobile Users' Voice Transmissions	a) The NEXCOM System shall generate to the NEXCOM/VSCE interface a Voice Preemption Confirmation signal during the assertion of preemption by the ground station.	RD Section: 3.1.1.4
3.2.3.6.5	Squelch Break	a) In DSB-AM mode, the NEXCOM System shall generate to the NEXCOM VSCE interface a Squelch Break signal, based on detection of a radio frequency transmission above a configurable threshold.	FAA-P-2883
3.2.3.6.5	Squelch Break	b) In DSB-AM mode, the NEXCOM System shall suppress the audio output, unless a radio frequency signal above a preset threshold is detected.	RD Section: 3.1.7.1
3.2.3.6.5	Squelch Break	c) In VDL Mode 3, the NEXCOM System shall generate to the NEXCOM/VSCE interface a Squelch Break signal, based on detection of a radio frequency transmission for that Talk Group's voice subchannel above a configurable threshold.	RTCA DO-224A Section: 3.3.5
3.2.3.6.5	Squelch Break	d) In VDL Mode 3, the NEXCOM System shall implement the squelch function based on RTCA DO-224A Section 3.3.5.	RTCA DO-224A Section: 3.3.5
3.2.3.6.6.1	PTT Mute/Attenuation	a) The NEXCOM System shall be configurable (on a per Talk Group basis) to mute (at the control site asserting PTT) any received uplink voice bursts attempting to provide audio to the VSCE interface.	FAA-E-2885
3.2.3.6.6.1	PTT Mute/Attenuation	b) The NEXCOM System shall be configurable (on a per Talk Group basis) to mute (at the control site) received uplink audio (provided to the VSCE interface) during the assertion of PTT.	FAA-E-2885
3.2.3.6.6.1	PTT Mute/Attenuation	c) The NEXCOM System shall be configurable (on a per Talk Group basis) to attenuate (at the remote site) received uplink audio during the assertion of PTT.	FAA-E-2885
3.2.3.6.6.1	PTT Mute/Attenuation	d) The NEXCOM System shall be configurable (on a per Talk Group basis) to continue to attenuate (at the remote site) received uplink audio from 0 to 600 ms, in 10 ms increments after the release of PTT at the remote site.	FAA-E-2885
3.2.3.6.6.2	Commanded Mute/Unmute	a) The NEXCOM System shall support mute/unmute of the received audio (at the radio site on a per Talk Group basis) based on the operator input (e.g., VSCE, MMC, etc.).	FAA-E-2885

SRD Section	SRD Title	Requirements	Source Document
3.2.3.6.6.3	Commanded Mute/Unmute Confirmation	a) The NEXCOM System shall provide confirmation of the received audio muting/unmuting (at the radio site on a per Talk Group basis) to the operator, while mute is asserted (e.g., VSCE, MMC, etc.).	FAA-E-2885
3.2.3.6.7.1	Ground Radio Resource Selection	a) The NEXCOM System shall select Ground Radio Resources (e.g., Main/Standby select/deselect or BUEC select/reset as necessary) for voice operation based on the operator input (e.g., VSCE, MMCWS, and/or MDT).	RD Section: 3.1.1.1
3.2.3.6.7.1	Ground Radio Resource Selection	b) The NEXCOM System shall support independent Ground Radio Resource Selection for voice operation by different Talk Groups.	RD Section: 3.1.1.1
3.2.3.6.7.1	Ground Radio Resource Selection	c) The NEXCOM System shall cause no loss of management and user information due to Ground Radio Resource Selection for voice operation.	SRD Section: 3.2.3.6.5.1a
3.2.3.6.7.1	Ground Radio Resource Selection	d) When any PTT is activated, the NEXCOM System shall inhibit the Ground Radio Resource Selection for that Talk Group (i.e., inhibit the re-routing of the voice and control signals and inhibit the switching of the antenna transfer relay).	FAA-E-2885 Section: 3.2.2.3.1
3.2.3.6.7.2	Ground Radio Resource Selection Confirmation	a) The NEXCOM System shall provide confirmation of Ground Radio Resource Selection to the Operator (e.g., VSCE, MMCWS, and/or MDT) upon completion of radio selection.	RD Section: 3.1.1.4
3.2.3.6.7.3	Automatic Ground Radio Resource Switching	a) When the Main and Standby radios are serviced by the same RIU, and so configured, the NEXCOM System shall automatically perform M/S radio switching from the selected radio to the alternate radio, without operator intervention, in the event of a failure of the selected radio.	RD Section: 3.1.9.1; Attachment 2 par. 8 Automatic Failure Detection and Fault Isolation
3.2.3.6.7.3	Automatic Ground Radio Resource Switching	b) The Automatic Ground Radio Resource Switching shall be disabled by subsequent operator manual Ground Radio Resource Selection (i.e., M/S radio selection).	SRD Section: 3.2.6.5.2a
3.2.3.6.7.3	Automatic Ground Radio Resource Switching	c) If the automatic Ground Radio Resource Switching is disabled by subsequent operator manual M/S radio selection, the automatic Ground Radio Resource Switching shall remain disabled until manually reset.	SRD Section: 3.2.6.5.2a
3.2.3.6.7.3	Automatic Ground Radio Resource Switching	d) Automatic Ground Radio Resource Switching shall only be performed when the alternate radio is operational.	SRD Section: 3.2.6.5.2a

SRD Section	SRD Title	Requirements	Source Document
3.2.3.6.8	Channel Busy Signal	a) The NEXCOM System shall provide a channel busy signal to the NEXCOM/VSCE interface that indicates the channel keyed by the controller is occupied by a downlink transmission.	RD Section: 3.1.7.1; Attachment 2 par. 8 Automatic Failure Detection and Fault Isolation
3.2.3.6.9	Dual Control	a) The NEXCOM System shall provide a dual control priority mode to share control of a Talk Group by two different control facilities.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	b) The NEXCOM System shall provide a dual control non-priority mode to share control of a Talk Group by two different control facilities.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	c) When a denial of access to the radio transmission path condition exists (lockout), as described in Sections 3.2.3.6.9.1 and 3.2.3.6.9.2, the NEXCOM System shall send a Lockout signal to the control facility being denied access.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	d) The NEXCOM System shall provide a PTT/PTT Release Confirmation signal back to the control facilities that has access to the radio transmission path.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	e) The NEXCOM System shall provide to both facilities the availability of communications on the receive path.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	f) When the mute function is selected within a control facility, the NEXCOM System shall mute the voice receive path for that facility independent of the mute selection of the other facility.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	g) When access to the transmission path is gained by one control facility, the NEXCOM System shall provide the transmit voice back to the other control facility.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9	Dual Control	h) Upon the termination of PTT by the control facility that has access to the radio transmission path, the lockout signal to the other control facility shall be removed.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1; FAA-E-2885 Section: 3.2.2.3.1.3
3.2.3.6.9.1	Priority Mode	a) Each control facility shall be defined as either a primary or a secondary control facility for the paired Talk Group.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.2
3.2.3.6.9.1	Priority Mode	b) When the primary control facility initiates a PTT assertion, the NEXCOM System shall provide access to the radio transmission path to the primary control facility.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.2

SRD Section	SRD Title	Requirements	Source Document
3.2.3.6.9.1	Priority Mode	c) During the conditions outlined in b), the NEXCOM System shall lockout the secondary control facility.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.1	Priority Mode	d) When the secondary control facility initiates a PTT assertion, and the primary control facility has not asserted PTT, the NEXCOM System shall provide access to the radio transmission path to the secondary control facility.	RD Section: 3.1.1.4; SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.2
3.2.3.6.9.2	Non-Priority Mode	a) Neither control facility shall be defined as a primary or a secondary control facility.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	b) When a control facility initiates a PTT assertion and a Voice Preemption assertion, during a PTT assertion and Voice Preemption assertion previously initiated by the other control facility, the NEXCOM System shall provide access to the radio transmission path to the control facility that asserted PTT first.	RD Section: 3.1.1.4; SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	c) During the conditions mentioned in b), the NEXCOM System shall lockout the control facility that did not assert PTT first.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	d) When a control facility initiates a PTT assertion and a Voice Preemption and the other control facility is not asserting Voice Preemption, the NEXCOM System shall provide access to the radio transmission path to the control facility that asserted both.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	e) During the conditions mentioned in d), the NEXCOM System shall lockout the control facility that did not assert both.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	f) When a control facility initiates a PTT assertion and a Voice Preemption and the other control facility is asserting the same signals, the NEXCOM System shall provide access to the radio transmission path to the control facility that asserted PTT first.	RD Section: 10.2.1.1; SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.6.9.2	Non-Priority Mode	g) During the conditions mentioned in f), the NEXCOM System shall lockout the control facility that did not assert PTT first.	SRD Section: 3.2.3.6.7; FAA-E-2885 Section: 3.2.2.3.1.3.1
3.2.3.7	Ground Stuck Microphone Correction	a) The NEXCOM System shall provide Ground Stuck Microphone Correction which can be enabled, that disables the uplink transmission for that Talk Group.	RD Section: 2.1; 3.2.1.2; 3.2.4.1; 3.2.4.2; FAA-P-2884
3.2.3.7	Ground Stuck Microphone Correction	b) Ground Stuck Microphone Correction shall have a configurable time component, so that when the duration of a PTT signal from a controller exceeds the configured time, transmission stops.	RD Section: 3.2.2.1; 3.3.1; 3.3.2; RTCA DO-224A, 3.3.2.1.1.1

SRD Section	SRD Title	Requirements	Source Document
3.2.3.7	Ground Stuck Microphone Correction	d) During Dual Control operation, the NEXCOM System shall reset the timer based on a controller gaining access to the radio transmission path.	RD Section: 3.2.2.1; 3.3.1; 3.3.2; RTCA DO-224A, 3.3.2.1.1.1
3.2.3.7	Ground Stuck Microphone Correction	c) The NEXCOM System shall allow the controller to reinitiate the transmission after Ground Stuck Microphone Correction has disabled the transmission by releasing the PTT command and reapplying it.	RD Section: 3.2.2.1; 3.3.1; 3.3.2; RTCA DO-224A, 3.3.2.1.1.1
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	a) The NEXCOM System telecommunications shall provide full-duplex operation.	RD Section: 4.10.2
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	b) The NEXCOM System shall operate with existing 4-wire analog telecommunications and selected digital telecommunications between control and remote radio facilities.	RD Section: 4.10.2
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	c) Analog telecommunications shall meet the interface requirements as specified in Telcordia TR-NWT-000335, based on FAA Order 6000.22A.	RD Section: 4.10.2; Telcordia TR-NWT-000335; FAA Order 6000.22A
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	d) Digital telecommunications shall meet the interface requirements specified in Telcordia GR-499-CORE, based on FAA Order 6000.47.	RD Section: 4.10.2; Telcordia GR-499-CORE; based on FAA Order 6000.47
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	e) The NEXCOM System shall support three telecommunication link redundancy configurations: 1. No backup 2. Standby telecommunications backup 3. Hot telecommunications backup	RD Section: 4.10.2
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	f) The NEXCOM System shall only use the bandwidth from 300 Hz to 3000 Hz for analog telecommunication service.	47 CFR Part 68
3.2.3.8.1	NEXCOM/Telecommunications Interfaces	g)The NEXCOM System shall be in compliance with 47 CFR Part 68 regarding c) and d) above.	47 CFR Part 68
3.2.3.8.2.1	Standby Telecommunications Restoration Functional Requirements	a) The NEXCOM System shall restore service over the original telecommunications link, for telecommunications service interruption of less than 1 second in duration.	FAA-E-2885

SRD Section	SRD Title	Requirements	Source Document
3.2.3.8.2.1	Standby Telecommunications Restoration Functional Requirements	b) When a backup telecommunications link is available, the NEXCOM System shall have a selectable function to restore service over the backup telecommunications link automatically, upon detection of the primary telecommunications link failure for telecommunications link service interruption that is 1 second or longer in duration.	FAA-E-2885
3.2.3.8.2.1	Standby Telecommunications Restoration Functional Requirements	c) Upon confirmation of restoration of the primary telecommunications link, and so configured, the NEXCOM System shall switch its operation back from the backup telecommunications link to the primary telecommunications link automatically.	FAA-E-2885
3.2.3.8.2.1	Standby Telecommunications Restoration Functional Requirements	d) When both systems are functioning properly, the automatic switch back to the primary telecommunications link shall be disabled until the PTT is de-asserted.	FAA-E-2885
3.2.3.8.2.2	Hot Telecommunications Backup Functional Requirements	a) Failure or any performance degradation to either one of the telecommunications interfaces in the hot backup configuration shall not degrade the NEXCOM System operation.	FAA-E-2885
3.2.4	Maintenance, Monitoring and Control (MMC) Functional Requirements	a) The NEXCOM System shall follow the following MMC hierarchy rules for control and monitoring: 1. Higher level subsystems have control and monitoring over lower level subsystems (i.e., GNI controls and monitors its RIU and MDR, and RIU controls and monitors its MDRs). 2. Equal level subsystems do not have control or monitor over each other (e.g., GNIs do not control or monitor each other, RIUs do not control or monitor each other), and MDRs do not control or monitor each other, except as stated in 5 and 6 below. 3. Lower level subsystems do not have control or monitor over higher level subsystems (e.g., MDR does not control or monitor the RIU and the GNI), except as stated in 4 below. 4. An RIU can monitor the GNI associated with that particular User Group. 5. An RIU can monitor, through the GNI, it's associated RIU/MDRs at separated sites. 6. A GNI can monitor GNIs that shares use of the same A/G Router.	RD Section: 7.2.1; 7.3.1.1

SRD Section	SRD Title	Requirements	Source Document
3.2.4.1.1	General Maintenance Requirements	a) The NEXCOM System shall meet the hardware maintenance requirements specified in FAA Order 6000.30C, National Airspace System Maintenance Policy.	RD Section: 2.2.1; 5.1.3; FAA Order 6000.30C
3.2.4.1.1	General Maintenance Requirements	b) For DSB-AM modes of operation, NEXCOM equipment shall be maintained with the support equipment, test equipment, and tools presently in the FAA inventory.	RD Section: 2.2.1; 8.3.1
3.2.4.1.1	General Maintenance Requirements	c) Individual Lowest Replaceable Units (LRUs) shall be designed to permit removal and replacement by a single person.	RD Section: 2.2.1; 6.2.4
3.2.4.2	Access	a) Access to MMC functions shall be by the following means: 1. Local MMC Access (see Section 3.2.4.2.1) 2. Remote MMC Access (See Section 3.2.4.2.2)	RD Section: 5.1.2; SRD Section 3.2.4.2.1; 3.2.4.2.2
3.2.4.2	Access	b) The NEXCOM System shall permit simultaneous monitoring for remote and local access in accordance with Section 3.2.4a.	RD Section: 5.1.2; SRD Section: 3.2.4a
3.2.4.2	Access	c) Local control access shall automatically inhibit remote control access.	RD Section: 5.1.2
3.2.4.2	Access	d) The NEXCOM System shall provide multiple privilege levels to control access to the NEXCOM MMC.	RD Section: 7.2.1; 7.3.1.1
3.2.4.2	Access	e) The MMC functions associated with each privilege level shall be configurable.	RD Section: 7.2.1; 7.3.1.1
3.2.4.2		f) The NEXCOM Subsystem shall utilize the same data for the local and remote MMC interfaces.	RD Section: 7.2.1; 7.3.1.1
3.2.4.2.1	Local MMC Access	a) The Local MMC Access shall provide on-site authorized personnel access to the MMC functions of directly connected NEXCOM Subsystem(s).	RD Section: 5.1.2; 7.2.1; 7.3.1.1
3.2.4.2.2	Remote MMC Access	a) The Remote MMC Access shall provide authorized personnel access to the MMC functions of indirectly connected NEXCOM Subsystems in accordance with Section 3.2.4.a.	RD Section: 5.1.2; 7.2.1; 7.3.1.1
3.2.4.2.2	Remote MMC Access	b) The Remote MMC Access shall provide the same functionality and capabilities as local MMC functions except for the local audio interface.	RD Section: 5.1.2
3.2.4.2.3	MMC Access Security	a) The NEXCOM System shall support the assignment of a unique logon identifier for each user.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	b) The NEXCOM System shall authenticate the claimed user's identity before allowing the user to perform any actions.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	c) When passwords are used for authentication, the NEXCOM System shall use strong passwords (i.e. prevent the use of dictionary words).	RD Section 5.1.1; 7.2.1; 7.3.1.1

SRD Section	SRD Title	Requirements	Source Document
3.2.4.2.3	MMC Access Security	d) The NEXCOM System shall enforce mandatory password changes at set intervals.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	e) The NEXCOM System shall prevent the reuse of passwords on a per user basis.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	f) The NEXCOM System shall execute a defined access control policy.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	g) The NEXCOM System shall enable access Authorization Management.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	h) The NEXCOM System shall enforce separation of duties through its role-based ability to restrict users to specific MMC functions, and to specific actions on those objects.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	i) The NEXCOM System shall provide resource allocation features having a measure of resistance to resource depletion (mitigate denial of service attacks).	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	j) The NEXCOM System shall temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	k) The NEXCOM System shall display a configurable banner page upon login.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.3	MMC Access Security	l) The NEXCOM System shall protect information system security data and functionality from all unauthorized access.	RD Section 5.1.1; 7.2.1; 7.3.1.1
3.2.4.2.4	NEXCOM/NIMS Interfaces	a) A NEXCOM/NIMS interface shall be at the GNIs with the NIMS agent.	RD Section: 5.1.2
3.2.4.2.4	NEXCOM/NIMS Interfaces	b) A NEXCOM/NIMS interface shall be at the A/G Router with a NIMS agent.	RD Section: 5.1.2
3.2.4.2.4	NEXCOM/NIMS Interfaces	c) The NEXCOM System shall authenticate all communications between NEXCOM and NIMS.	RD Section: 5.1.2; 7.2.1; 7.3.1.1
3.2.4.2.4	NEXCOM/NIMS Interfaces	d) The NEXCOM System and the NIMS System shall provide integrity assurance for the information flow between NEXCOM and NIMS.	RD Section: 5.1.2; 7.2.1; 7.3.1.1
3.2.4.2.4	NEXCOM/NIMS Interfaces	e) The NEXCOM System shall assure the integrity of all NEXCOM information being sent to NIMS.	RD Section: 5.1.2
3.2.4.3	Service/System/Subsystem Certification Requirements	a) The NEXCOM System shall provide remote monitoring information with sufficient accuracy to verify the correct configuration and operation of each subsystem.	RD Section: 5.1.3; FAA-E-2911 Section: 3.2.1.1b; 6000.15C Chapter 5

SRD Section	SRD Title	Requirements	Source Document
3.2.4.3	Service/System/Subsystem Certification Requirements	b) The NEXCOM System shall provide remote monitoring information with sufficient accuracy to verify the correct configuration and operation of the A/G communications service.	RD Section: 8.7.1.1; 5.1.3; FAA-E-2911 Section 3.2.1.1b
3.2.4.3	Service/System/Subsystem Certification Requirements	c) The NEXCOM System shall periodically verify the following: 1. Mode of operation 2. Subsystem configuration 3. Subsystem/LRU status 4. Operational status of each Talk Group	RD Section: 8.7.1.1; 5.1.3; FAA-E-2911
3.2.4.3	Service/System/Subsystem Certification Requirements	d) The NEXCOM System shall alert to the appropriate system managers/logs (e.g., MMCWS, NIMS) if the verification detects an anomaly (e.g., subsystem configured differently than the manager database indicates).	RD Section: 7.3.3.1; 7.4.1; FAA Order 1370.82
3.2.4.4.1	Monitored Parameter Status	a) The system/subsystem level parameters to be monitored shall include the following: 1. Mode of Operation (i.e., 25 kHz DSB-AM, VDL Mode 3, or 8.33 kHz DSB-AM) 2. Ground System Configuration (e.g., Diversity site group operation, VDL Mode 3 System Configuration) 3. RF Link Status 4. Telecommunications Status 5. Subsystem/LRU Status (e.g., Up/Down status for Main/Standby/BUEC elements) 6. Data Subnetwork Status 7. Timing Source Status 8. Operational status of each Talk Group (e.g. PTT asserted, Main or Standby TX and/or RX selection, etc).	RD Section: 5.1.3; 3.3.3; 3.1.7; 3.1.7.1; 3.2.4; RTCA DO-224A Section: 2.4.2
3.2.4.4.1	Monitored Parameter Status	b) Upon restoral of connectivity to a remote device, the NEXCOM System shall report as alerts to the appropriate system managers/logs (e.g., MMCWS, NIMS), any configuration changes since the last indication.	
3.2.4.4.1.1	Performance Status Monitoring	a) The NEXCOM System shall collect and present the workload of system resources.	FAA-E-2911 3.2.1.2.3 a; FAA Order 6000.4

SRD Section	SRD Title	Requirements	Source Document
3.2.4.4.1.1	Performance Status Monitoring	b) The NEXCOM System shall collect and present the throughput of system resources.	FAA-E-2911 3.2.1.2.3 b; FAA Order 6000.4
3.2.4.4.1.1	Performance Status Monitoring	c) The NEXCOM System shall collect and present the response time of system resources.	FAA-E-2911 3.2.1.2.3 b; FAA Order 6000.4
3.2.4.4.2	Alerting/Alarming	a) System alarms/alerts shall be sent automatically to: 1. The Local MMC interface 2. The Remote MMC interface in accordance with Section 3.2.4 a)	SRD Section: 3.2.4a; RD Section: 5.1.3; FAA-E-2911 Section: 3.2.1.2.1a through 3.2.1.2.1e
3.2.4.4.2	Alerting/Alarming	b) A system alarm/alert shall automatically trigger the alarm/alert indicator on the front panel of the associated NEXCOM Subsystems.	RD Section: 5.1.3; FAA-E-2911 Section: 3.2.1.2.1a through 3.2.1.2.1e
3.2.4.4.2	Alerting/Alarming	c) NEXCOM Subsystems shall forward any alert/alarm received from a remotely monitored NEXCOM Subsystem according to the NEXCOM MMC System Hierarchy discussed in Section 3.2.4 a).	SRD Section: 3.2.4a; RD Section: 5.1.3; FAA-E-2911 Section: 3.2.1.2.1a through 3.2.1.2.1e
3.2.4.4.3	MMC Data Logging	a) The NEXCOM System shall log the following: 1. Alerts 2. Alarms 3. Identifications of system configuration and the system components that are changed along with parameter values and the unique identifier of the individual making the change 4. All control access attempts and the unique identifier of the individual making the attempt	RD Section: 5.1.2; 5.1.3; FAA-E-2911 Section: 3.2.1
3.2.4.4.3	MMC Data Logging	b) The NEXCOM System shall provide for archiving of log data.	RD Section: 5.1.3; FAA-E-2911, 3.2.1a through 3.2.1e
3.2.4.4.3	MMC Data Logging	c) The NEXCOM System shall time stamp the data log with the time the information was generated by the originating subsystem.	RD Section: 5.1.3; FAA-E-2911, 3.2.1a through 3.2.1e
3.2.4.4.3	MMC Data Logging	d) The NEXCOM System shall protect logs against unauthorized deletion and modification, even by system security administrators.	RD Section: 5.1.3
3.2.4.4.3	MMC Data Logging	e) The NEXCOM System shall support centralized security incident reporting.	RD Section: 5.1.3

SRD Section	SRD Title	Requirements	Source Document
3.2.4.5	System Control Requirements	a) The NEXCOM System shall have control functions that allow authorized personnel to adjust designated parameters or exercise designated operational controls for specific subsystems (e.g., Frequency Tuning, VDL Mode 3 System Configuration, and Diversity Site Configuration).	RD Section: 5.1.3
3.2.4.5	System Control Requirements	b) The NEXCOM System shall terminate control access to any subsystem after a configurable amount of control inactivity.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	a) The NEXCOM System shall include built-in tests and diagnostic functions to detect equipment failures and isolate equipment faults to the LRU level.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	b) Diagnostic results and equipment faults shall be available via the local and remote MMC interfaces.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	c) At startup of any NEXCOM Subsystem, the system shall perform a self-check for the following: 1. Correct operation of the system 2. Presence and correct operating capability of the security functions	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	d) If the self-check function of c) above fails, the NEXCOM System shall generate an alarm.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	e) The NEXCOM System shall permit operation of the affected NEXCOM Subsystem(s) only if the self-check function of c) above passes.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	f) If the self-check of the security functions of c) above passes, the NEXCOM System shall perform all operations.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	g) The NEXCOM System shall include diagnostic functions to automatically detect system anomalies that would interfere with the correct operation, security and/or maintenance of the system.	RD Section: 5.1.3
3.2.4.6.1	Diagnostics and Fault Detection	h) The NEXCOM System shall support the commanded operational, security and maintenance of self-test.	RD Section: 5.1.3
3.2.4.6.2	Telecommunications Monitoring	a) The NEXCOM Subsystems that interface with telecommunications functions shall detect telecommunications (except MDRs analog interface) link failure.	RD Section: 5.1.3; FAA-E-2885
3.2.4.6.2	Telecommunications Monitoring	b) Upon loss of telecommunications service for a site/channel, the affected site/channel shall inhibit its RF transmissions automatically.	RD Section: 5.1.3; FAA-E-2885
3.2.4.6.3	LRU Addressability	a) Every NEXCOM MMC capable LRU shall be uniquely addressable.	RD Section: 5.1.2

SRD Section	SRD Title	Requirements	Source Document
3.2.4.7.1	Momentary Interruption Impact	a) The system/subsystem operation shall not be affected by momentary interruptions.	RD Section: 3.2.15.1; 3.2.10.1; 4.6.1; 4.9.1; 10.2.1;
3.2.4.7.2	Power Failure Recovery	a) Upon power restoration, the subsystem shall verify proper operation, and (if possible) resume operation.	RD Section: 3.2.15.1; 3.2.10.1; 4.6.1; 4.9.1; 10.2.1;
3.2.4.8	Equipment Hot Swapping	a) The NEXCOM System shall support removal and replacement of LRUs without requiring the NEXCOM Subsystems to be powered-down.	RD Section: 3.2.15.1; 3.2.10.1; 4.6.1; 4.9.1; 10.2.1;
3.2.4.9	General Data Interfaces	a) The NEXCOM System shall provide general purpose data interfaces for external devices to communicate between an RIU and associated GNI(s).	FAA-E-2885
3.2.4.9	General Data Interfaces	b) These general data interfaces shall have a lower priority than voice, data, or MMC.	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	a) The NEXCOM System shall support general purpose discrete Inputs and Outputs (I/Os).	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	b) The NEXCOM System shall allow for selectable monitoring of discrete I/Os.	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	c) When discrete item monitoring is selected/enabled, the NEXCOM System shall generate a user defined MMC message based on I/O state change.	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	d) The NEXCOM System discrete I/Os shall be mappable so that an input at a control site can generate at least one corresponding output at a remote site.	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	e) The NEXCOM System discrete I/Os shall be mappable so that an input at a remote site can generate at least one corresponding output at a control site.	FAA-E-2885
3.2.5.1.1	Discrete I/O Utilization	f) The NEXCOM System discrete outputs shall be mappable to alarm/alert messages generated within the NEXCOM System (e.g., Telecommunications link failure status generating a discrete output).	FAA-E-2885
3.2.5.1.1.1	Unused Interfaces	a) LRUs shall have spare I/O pins available for future expansion as subsystem requirements specify.	RD Section: 3.2.14.1
3.2.5.1.2	Vocoder	a) The vocoder function shall be upgradeable with additional algorithms.	RD Section: 3.2.14.1 RTCA DO-224A Section: 3.3.5.2.1
3.2.5.2	Software	a) The NEXCOM System shall be upgradeable with new software.	RD Section: 3.2.14.1

SRD Section	SRD Title	Requirements	Source Document
3.2.5.2.1	Software Upgrade	a) An MMC function shall be provided to upgrade software by uploading new versions of application or operating system software in accordance with the MMC control hierarchy defined in Section 3.2.4 a).	RD Section: 3.2.14.1; SRD Section: 3.2.4a
3.2.5.2.1	Software Upgrade	b) An MMC function shall be provided to delete any version of software or operating system software other than the software in operation.	SRD Section: 3.2.5.2
3.2.5.2.2	Software Version Selection	a) An MMC function shall be provided that allows the selection of different versions of installed software, should more than one version be present.	SRD Section: 3.2.5.2
3.2.5.2.3	Software Version Switch Failure Reversion	a) Upon failure of switching to a new software version, the device shall revert to the previous version of software.	SRD Section: 3.2.5.2
3.2.5.2.4	Software Upload Authentication	a) The NEXCOM System shall provide authentication for all software uploads.	RD Section: 7.2.1; 7.3.1.1
3.2.5.2.4	Software Upload Authentication	b) The NEXCOM System shall provide integrity assurance for all software uploads.	RD Section: 7.2.1; 7.3.1.1
3.2.5.2.4	Software Upload Authentication	c) Software upload attempts shall be reported as system alerts to the MMC system for the following modes: 1. Authentication failure 2. Data Integrity failure 3. Successful uploads	RD Section: 7.2.1; 7.3.1.1
3.2.5.2.4	Software Upload Authentication	d) When software upload failure is detected, the NEXCOM System shall reinitiate software upload only upon receiving a new upload command.	RD Section: 7.2.1; 7.3.1.1
3.2.5.2.4	Software Upload Authentication	e) When software upload failure is detected, the NEXCOM System shall delete the failed upload from memory.	RD Section: 7.2.1; 7.3.1.1
3.2.6.1	Common Time Conditioning	a) The NEXCOM System shall provide a Timing Source.	SRD Section: 3.2.2.1; Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.2.6.1	Common Time Conditioning	b) The NEXCOM System shall derive system time from the NEXCOM Timing Source per Section 3.3.6.1.1.	Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8

SRD Section	SRD Title	Requirements	Source Document
3.2.6.1	Common Time Conditioning	c) The NEXCOM Timing Source shall accept conditioning from an external Timing Reference.	Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.2.6.2	Timing Distribution	a) The NEXCOM System shall support multiple collocated RIUs to synchronized from a single Timing Source.	SRD Section: 3.2.2.1; Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.2.7.1	Reliability	a) The NEXCOM System shall support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.	RD Section: 3.2.1.2; NAS-SR-100
3.2.7.1.1	Single Point of Failure	a) No single failure within the NEXCOM System shall cause loss of User Group communications.	RD Section: 3.2.1.2; NAS-SR-1000, 3.8.1c
3.2.7.2	Maintainability	a) The NEXCOM System shall support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.	RD Section: 3.2.3.1; NAS-SR-100
3.2.7.3	Availability	a) The NEXCOM System shall support critical services per NAS-SR-1000, Section 3.8.1, for voice and data.	RD Section: 3.2.4.1; NAS-SR-100
3.2.8	Security Measures	a) The NEXCOM System shall log the occurrence of security related events, including attempts to login, attempts of file transfer, and data file modifications.	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	b) The NEXCOM System shall alarm upon suspected intrusions.	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	c) The NEXCOM System shall detect malicious code and data (e.g. viruses and worms).	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	d) The NEXCOM System shall provide a means to remove detected malicious code and data (e.g. viruses and worms).	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	e) The NEXCOM System shall support the maintenance of detection and removal functions identified in c) and d) above.	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	f) The NEXCOM System shall generate alerts when file integrity is compromised.	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	g) The NEXCOM System shall implement screening/firewall/proxy server functionality to meet security requirements.	RD Section: 7.3.3.1; 7.4.1
3.2.8	Security Measures	h) The NEXCOM System shall provide resource allocation features having a measure of resistance to resource depletion (mitigate denial of service attacks).	RD Section: 7.3.3.1; 7.4.1

SRD Section	SRD Title	Requirements	Source Document
3.2.8	Security Measures	i) The NEXCOM System shall authenticate all NEXCOM ground communications.	
3.2.8	Security Measures	j) The NEXCOM System shall provide integrity assurance for the information within NEXCOM.	
3.3	NEXCOM System Performance Requirements	a) The NEXCOM System shall meet or exceed the operational coverage area provided by the current analog voice system without degradation of service quality or increase of user workload beyond the workload of the current voice system.	RD Section: 3.2.10.1; 6.3.1
3.3.1.1.1	Power and Grounding	a) The NEXCOM System shall meet the power and grounding requirements of FAA-G-2100G.	RD Section: 4.6.1; 6.2.5; 8.9.1; FAA-G-2100G
3.3.1.1.1.1	Lightning Protection	a) The NEXCOM System shall provide lightning, transient protection, and harmonic suppression consistent with IEEE/ANSI Standards C62.36-1994, IEEE/ANSI Standards C62.41-1991, IEEE/ANSI Std 519-1992, and IEEE/ANSI Standards C62.31-1987, for the following interfaces where applicable: 1. Power 2. Telecommunications 3. Antenna	RD Section: 4.3.2; 4.6.1
3.3.1.1.2.1	Size	a) Each NEXCOM Subsystem shall be 19" rack-mountable into standard Electronic Industries Association-310 (EIA-310) rack.	RD Section: 4.2.2
3.3.1.1.2.1	Size	b) Each NEXCOM LRU shall be no more than 18 inches in depth, including connectors.	RD Section: 4.2.2
3.3.1.1.2.1	Size	c) Each NEXCOM Subsystem shall be mounted into a rack(s) that is at less than or equal to 84 inches tall.	
3.3.1.1.3	Cable Requirements	a) All NEXCOM cables shall meet the performance requirements specified in the following: 1. NFPA Standard 70, National Electrical Code 2. FAA Order 6630.4A, En Route Communications Installation Standards Handbook, Chapter 6, Section 3 3. FAA-C-1217F Electrical Work, Interior	RD Section: 4.2.1; 4.7.1; 4.7.2; 4.7.3
3.3.1.1.4.1	Pollution Control Requirements	a) The NEXCOM System shall meet the pollution control requirements specified in Executive Order 12088, Federal Compliance with Pollution Control Standards.	RD Section: 4.3.1

SRD Section	SRD Title	Requirements	Source Document
3.3.1.1.4.1	Pollution Control Requirements	b) The NEXCOM System shall meet the pollution control requirements specified in Executive Order 13101, Greening the Government through Waste Prevention, Recycling, and Federal Acquisition.	RD Section: 4.3.1
3.3.1.1.4.1	Pollution Control Requirements	c) The NEXCOM System shall meet the pollution control requirements specified in Executive Order 12873, Federal Acquisition, Recycling, and Waste Prevention.	RD Section: 4.3.1
3.3.1.1.4.1	Pollution Control Requirements	d) The NEXCOM System shall minimize the generation of hazardous wastes as defined in 40 CFR 261, Identification and Listing of Hazardous Wastes.	RD Section: 4.3.1
3.3.1.1.4.2	Energy Conservation Requirements	a) The NEXCOM System shall meet the energy conservation requirements specified in Executive Order 13123, Greening the Government Through Efficient Energy Management.	RD Section: 4.4.1
3.3.1.1.4.2	Energy Conservation Requirements	b) The NEXCOM System shall meet the requirements of Executive Order 12902, Energy Efficiency and Conservation at Federal Facilities.	RD Section: 4.4.1
3.3.1.1.5.1	Electrical Safety Requirements	a) The NEXCOM System shall meet the personnel safety requirements specified in FAA-G-2100G.	RD Section: 4.2.1; 4.3.2; 6.2.1
3.3.1.1.5.1	Electrical Safety Requirements	b) Facility electrical modifications to support the NEXCOM System shall comply with the requirements of NFPA 70.	RD Section: 4.2.1; 4.3.2; NFPA 70
3.3.1.1.5.2	Hazardous Materials	a) The NEXCOM System shall be free of asbestos, polychlorinated biphenyls (PCBs), lead, and class 1 ozone depleting substances.	RD Section: 4.2.1; 4.8.1; 4.8.2; 4.3.2; 6.2.3; 8.0
3.3.1.1.5.2	Hazardous Materials	b) The NEXCOM System shall limit personnel exposure to hazardous materials to the levels permitted by 29 CFR 1910 Subpart Z.	RD Section: 4.8.1; 4.3.2; 6.2.3; 29 CFR 1910, Subpart Z
3.3.1.1.5.3	Personnel Safety Requirements	a) The NEXCOM System shall comply with the requirements of 29CFR Parts 1910 and 1926.	RD Section: 6.2.1; 6.2.2; 6.2.3
3.3.1.1.5.3	Personnel Safety Requirements	b) The NEXCOM System shall comply with FAA Order 3900.19B.	RD Section: 6.2.1; 6.2.2; 6.2.3
3.3.1.1.5.4	Seismic Safety	a) New construction supporting the NEXCOM System shall be in accordance with 49 CFR Part 41.	RD Section: 4.3; DOT implementation of EO 12699 Section: 3.8.4.4.1.2
3.3.1.1.5.4	Seismic Safety	b) The NEXCOM System elements installed in existing facilities shall be in accordance with FEMA-74.	RD Section: 4.3; DOT-SS-98-01 - DOT policy for EO 12941

SRD Section	SRD Title	Requirements	Source Document
3.3.1.1.5.5	Equipment Safety	a) Connecting cables consistent with proper operation to or disconnecting cables from equipment in the NEXCOM System while the equipment is powered and the system is in operation shall not cause damage to any equipment in the NEXCOM System.	RD Section: 4.7
3.3.1.1.5.6	Acoustic Noise	a) The total acoustic noise emanated by NEXCOM Systems that are installed in any locations shall not exceed the specifications defined in FAA-G-2100G, Noise Criteria Requirement.	RD Section: 4.3.2
3.3.1.2.1	Radio Frequency Interference and Electromagnetic Interference Requirements	a) The NEXCOM System shall meet the RFI/EMI requirements specified in FAA-G-2100G.	RD Section: 3.2.13.1; 4.3.2; FAA-G-2100G
3.3.2.1	VDL Mode 3 Standardization	a) The NEXCOM System shall meet the VDL Mode 3 performance requirements for ground systems specified in RTCA DO-224A.	SRD Section: 3.2.2.1; RTCA DO-224A
3.3.2.1	VDL Mode 3 Standardization	b) The NEXCOM System shall meet United States regulatory performance requirements specified in, NTIA, etc.	SRD Section: 3.2.2.2
3.3.2.1	VDL Mode 3 Standardization	c) When there are conflicts between a) and b) above, the more stringent requirement shall take precedence.	SRD Section: 3.2.2.3
3.3.2.2	25 kHz DSB-AM Standardization	a) The NEXCOM System shall meet the 25 kHz DSB-AM performance requirements specified in FAA-P-2883 and FAA-P-2884.	SRD Section: 3.2.2.2; FAA-P-2883; FAA-P-2884
3.3.2.3	8.33 kHz DSB-AM Standardization	a) The NEXCOM System shall meet the 8.33 kHz DSB-AM performance requirements specified in ICAO Annex 10 and ETSI EN-300-676.	SRD Section: 3.2.2.3; ICAO Annex 10 and ETSI EN-300-676
3.3.3.1.1	Voice Channels	a) The NEXCOM System shall support a control facility with at least 350 voice channels per control facility.	SRD Section: 3.2.3.1.1
3.3.3.1.2	Voice Quality/Intelligibility	a) The NEXCOM System shall not degrade the voice quality/intelligibility in a statistically significant manner from the current DSB-AM mode.	RD Section: 3.2.6.1
3.3.3.1.2.1	Audio Clipping	a) The NEXCOM System shall not truncate the voice signal received or transmitted.	RD Section: 3.2.8.1
3.3.3.1.3.1	Uplink Path	a) The uplink audio throughput delay shall be no greater than 217 milliseconds (ms) in analog voice mode.	RD Section: 3.2.7.1; SRD Section: 3.2.3.1.3.1; Appendix F

SRD Section	SRD Title	Requirements	Source Document
3.3.3.1.3.1	Uplink Path	b) The uplink audio throughput delay shall be no greater than 173 ms in digital voice mode.	RD Section: 3.2.7.1; SRD Section: 3.2.3.1.3.1; Appendix F
3.3.3.1.3.2	Downlink Path	a) The downlink audio throughput delay shall be no greater than 175 ms in analog voice mode.	RD Section: 3.2.7.1; SRD Section: 3.2.3.1.3.2; Appendix F
3.3.3.1.3.2	Downlink Path	b) The downlink audio throughput delay shall be no greater than 61 ms in digital voice mode.	RD Section: 3.2.7.1; SRD Section: 3.2.3.1.3.2; Appendix F
3.3.3.2.1.1	Router Network Size	a) The NEXCOM System shall use between 2 and 48 A/G Routers for the NAS.	SRD Section: 3.2.3.2.1.1
3.3.3.2.1.2	Minimization of ATN Port Usage	a) The NEXCOM System shall provide a data switching function(see Appendix B.2.3.3) to concentrate GNI connectivity to a limited number of A/G Router ports.	SRD Section 3.3.3.2.1.1
3.3.3.2.1.3	Subnetwork Integrity	a) The NEXCOM subnetwork shall guarantee a probability of undetected packet error of less than 10^{-9}.	ICAO Doc 9705
3.3.3.2.1.4	Subnetwork Transit Delay	a) The NEXCOM System shall successfully communicate 95% of the packets from one end of the subnetwork to the other based on the required class of service per Table 3-1.	ICAO Doc 9705 Table 5.2-2
3.3.3.2.1.4.1	Traffic Loading	a) The NEXCOM System shall support the traffic identified in Table 3-2 at the specified performance level.	ICAO Doc 9705 Table 5.2-2
3.3.3.3	Continuous Broadcast	a) The NEXCOM System shall operate at up to 100 percent duty cycle in DSB-AM.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1
3.3.3.3	Continuous Broadcast	b) The NEXCOM System shall operate at up to 79.5 percent duty cycle in VDL Mode 3.	RD Section: 3.2.15.1; 3.2.10.1; 10.2.1
3.3.3.4.3	Subnetwork Leave Event Issuance Delay	a) The NEXCOM System shall issue Leave Events to the A/G router based on the required class of service 95% of the time per Table 3-3, measured from when the connection is lost to when the Leave Event is sent to the A/G router. Different performance is specified depending on whether or not data traffic is present.	ICAO Doc 9705 Table 5.2-2
3.3.3.5	Ground Station Operations	a) The NEXCOM System shall support up to four User Groups on the same VDL Mode 3 frequency assignment.	SRD Section: 3.2.3.5; RD Section: 3.2.12.1

SRD Section	SRD Title	Requirements	Source Document
3.3.3.5	Ground Station Operations	b) Each NEXCOM Talk Group’s voice communications resources shall be controllable independent from all other Talk Groups’ voice communications resources.	RD Section: 3.1.1.1; SRD Section: 3.2.3.5
3.3.3.5	Ground Station Operations	c) The NEXCOM System shall support operation of multiple ground sites for one User Group in a sector having two to twelve diversely located RCFs.	SRD Section: 3.2.3.5
3.3.3.5	Ground Station Operations	d) The NEXCOM System shall provide uplink M Beacons to all Mobile Users within a service volume to maintain timing state TS1 as defined as defined in RTCA DO-224A.	SRD Section: 3.2.2.1; RTCA DO-224A
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	a) For VDL Mode 3, the NEXCOM System shall transmit/cease transmit audio within 175 ms of the arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.	RD Section: 3.1.4.1; 3.2.7.1; FAA-E-2885 Section: 3.2.3.2.2.1
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	b) During sustainment, DSB-AM modes of operation using an analog audio interface, the NEXCOM System shall transmit RF to 90% output power within 100 ms of the arrival of the PTT signal at the NEXCOM/VSCE interface for 99.9% of the PTT events.	RD Section: 3.1.4.1; 3.2.7.1; FAA-E-2885 Section: 3.2.3.2.2.1
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	c) During sustainment, DSB-AM modes of operation using an analog audio interface, the NEXCOM System RF output shall decay to 10% of the set output power within 100 ms of the arrival of the PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the PTT Release events.	RD Section: 3.1.1.4; 3.1.4; 3.2.7.1; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	d) For DSB-AM modes of UHF radio operation, the NEXCOM System shall deliver PTT/PTT Release signal to the RIU/Analog Radio interface within 193 ms of the arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.	RD Section: 3.1.1.4; 3.1.4; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	e) For DSB-AM modes of UHF radio operation, the NEXCOM System shall deliver the PTT signal to the RIU/Analog Radio interface from 15 - 25 ms before the audio is presented at the interface.	RD Section: 3.1.1.4; 3.1.4; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1
3.3.3.6.1	Push-to-Talk Transmitter Keying (PTT/PTT Release)	f) For DSB-AM modes of operation using the RIU/MDR Digital interface (using PCM audio), the NEXCOM System shall transmit/cease transmit audio within 217 ms of arrival of the PTT/PTT Release signal at the NEXCOM/VSCE interface for 99.9% of the events.	RD Section: 3.1.1.4; 3.1.4; 3.2.7.1; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1

SRD Section	SRD Title	Requirements	Source Document
3.3.3.6.2	PTT/PTT Release Confirmation	a) In DSB-AM modes of UHF radio operation using the RIU/analog radio interface, the NEXCOM System shall indicate to the NEXCOM/VSCE interface the confirmation of PTT activation received by the RIU from the UHF transmitter within 100 ms for 99.9% of the PTT/PTT Release Confirmation events.	RD Section: 3.1.1.4; 3.1.4; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1
3.3.3.6.2	PTT/PTT Release Confirmation	b) The NEXCOM System shall indicate to the NEXCOM/VSCE interface the confirmation of audio transmission within 350 ms for 99.9% of the PTT/PTT Release Confirmation events.	RD Section: 3.1.1.4; 3.1.4; 10.2.1.1; FAA-E-2885 Section: 3.2.3.2.2.1.1; SRD Section: 3.2.3.6.1
3.3.3.6.3	Preemption of Mobile Users' Voice Transmissions (Controller Override)	a) The NEXCOM System shall initiate transmission of a VDL Mode 3 Voice Preemption signal in the next two scheduled uplink M-burst opportunities for the associated primary and backup radio sites when the condition of simultaneous presence of a Voice Preemption control signal and a PTT occurs at the NEXCOM/VSCE interface.	SRD Section: 3.2.3.6.2; 3.2.2.1
3.3.3.6.3	Preemption of Mobile Users' Voice Transmissions (Controller Override)	b) The Voice Preemption signal shall be contained in the next scheduled uplink Beacon that occurs at least 50 ms after the reception of the Voice Preemption and PTT signals from the NEXCOM/VSCE interface for 99.9% of the preemption events.	RD Section: 3.3.1; ICAO Doc X (Manual for the Implementation of VDL Mode 3) 3.3.1; 4.6; SRD Section: 3.4.3.2.2
3.3.3.6.3	Preemption of Mobile Users' Voice Transmissions (Controller Override)	c) When configured for diversity site group operation and during an attempted Voice Preemption, the NEXCOM System shall disable current downlink transmissions with the next uplink M-burst opportunity.	SRD Section: 3.2.3.6.2; 3.2.2.1
3.3.3.6.4	Preemption Confirmation of Mobile Users' Voice Transmissions	a) The NEXCOM System shall provide, back to the NEXCOM/VSCE interface, confirmation of Voice Preemption activation within 350 ms of its transmission for 99.9% of the events.	SRD Section: 3.2.3.6.2; 3.2.2.1
3.3.3.6.5	Squelch Break	a) The NEXCOM System shall indicate to the NEXCOM/VSCE interface Squelch Breaks in the receiver within 100ms for 99.9% of the Squelch Break indication events.	SRD Section: 3.2.3.6.3
3.3.3.6.6.1	PTT Mute/Attenuation	a) The audio attenuation shall be configurable for 0, 15, or 20 dB.	SRD Section: 3.2.3.6.4.1; FAA-E-2885
3.3.3.6.6.1	PTT Mute/Attenuation	b) The audio attenuation delay shall be configurable in duration from 0 to 600 ms, in 10 ms increments after release of PTT at the remote site.	SRD Section: 3.2.3.6.4.1; FAA-E-2885

SRD Section	SRD Title	Requirements	Source Document
3.3.3.6.6.2	Commanded Mute/Unmute	a) The NEXCOM System shall mute/unmute the received audio within 105 ms for 99.9% of the Commanded Mute/Unmute events.	FAA-E-2885 Section: 3.2.3.2.2.3
3.3.3.6.6.3	Commanded Mute/Unmute Confirmation	a) The NEXCOM System shall provide received Commanded Mute/Unmute Confirmation to the NEXCOM/VSCE interface within 350 ms for 99.9% of the Commanded Mute/Unmute events.	FAA-E-2885 Section: 3.2.3.2.2.3.1
3.3.3.6.7.1	Ground Radio Resource Selection	a) The NEXCOM System shall switch radio resources (e.g., Main/Standby Select/Deselect, or BUEC Select/Reset as necessary) within 100 ms of receipt of the signal from the NEXCOM/VSCE interface for 99.9% of the Ground Radio Resource Selection events.	SRD Section: 3.2.3.6.5; FAA-E-2885 Section: 3.2.3.2.2.2
3.3.3.6.7.2	Ground Radio Resource Selection Confirmation	a) The NEXCOM System shall confirm radio resource selection (e.g., Main/Standby select/deselect or BUEC Select/Reset as necessary) within at most 250 ms from the time of switching for 99.9% of the Ground Radio Resource Selection events.	RD Section: 3.1.1.4; SRD Section: 3.2.3.6.5.1; FAA-E-2885 Section: 3.2.3.2.2.2.1
3.3.3.6.7.3	Automatic Ground Radio Resource Switching	a) The NEXCOM System shall switch from the failed radio to the operational alternate radio and be ready to operate over the alternate radio within 30 ms after detection of the radio failure.	SRD Section: 3.2.3.6.5.2
3.3.3.6.8	Channel Busy Signal	a) The NEXCOM latency for the Channel Busy indicator shall be at most 125 ms for 99.9% of the channel busy events.	
3.3.3.6.9	Dual Control	a) The NEXCOM latency for the VHF/UHF Lockout indicator shall be at most 125 ms for 99.9% of the lockout events.	FAA-E-2885, 3.2.3.2.2.3
3.3.3.7	Ground Stuck Microphone Correction	a) The Ground Stuck Microphone timeout shall be configurable to be enabled or disabled.	
3.3.3.7	Ground Stuck Microphone Correction	b) The Ground Stuck Microphone timeout, when enabled, shall be configurable from 5 seconds to 5 minutes in 5 second increments.	RD Section: 3.3.1; 3.3.2; RTCA DO-224A Section: 3.3.2.1.1.1
3.3.3.8.1	Telecommunications Delay and Delay Variations	a) The NEXCOM System shall operate when the telecommunications one-way delay is up to 600 ms.	FAA-E-2885; SRD Section: 3.2.3.8.1
3.3.3.8.1	Telecommunications Delay and Delay Variations	b) The NEXCOM System shall operate with transfer delay variations.	FAA-E-2885; SRD Section: 3.2.3.8.1
3.3.3.8.1	Telecommunications Delay and Delay Variations	c) The NEXCOM System transfer delay shall be minimized based on the characteristics of the telecommunications media.	FAA-E-2885; SRD Section: 3.2.3.8.1

SRD Section	SRD Title	Requirements	Source Document
3.3.3.8.2	Telecommunications Restoration Performance	a) The restoration time, defined to be the combined time to detect the link failure, and to restore operations, shall be 6 seconds or less.	FAA-E-2885; NAS-SR-1000
3.3.3.8.2	Telecommunications Restoration Performance	b) For telecommunications service interruption of less than 1 second in duration, the NEXCOM System shall restore the communications service within 120 ms after the condition that caused the service interruption is removed.	FAA-E-2885
3.3.3.8.2	Telecommunications Restoration Performance	c) The NEXCOM System shall switch its operation from the backup telecommunications link to the primary telecommunications link within 3 seconds after the PTT is de-asserted upon restoration of the primary telecommunications link , without loss of data.	FAA-E-2885
3.3.3.8.2.1	Standby Telecommunications Restoration Performance	a) When a backup telecommunications link is available and the NEXCOM System is in the standby telecommunications backup configuration, the NEXCOM System shall restore operation from the primary telecommunications link to the backup telecommunications link in 1 second or less after detection of the primary telecommunications service failure.	SRD Section: 3.2.3.8.2.1; FAA-E-2885
3.3.3.8.2.1	Standby Telecommunications Restoration Performance	b) When configured for standby telecommunications backup after the primary link has failed, the NEXCOM System shall switch its operation from the backup telecommunications link to the primary telecommunications link within 3 seconds after the primary telecommunications link is restored, without loss of data.	SRD Section: 3.2.3.8.2.1; FAA-E-2885
3.3.4.1.1	LRU Maintenance	a) Maintenance of individual LRUs shall meet the requirements specified in FAA-G-2100G.	FAA-G-2100G
3.3.4.1.2	Non-Interference MMC	a) The NEXCOM MMC function shall not degrade system performance unless a commanded self-test, supported in Section 3.2.4.6.1 h), requires that the NEXCOM System temporarily prohibit operational use for the thread(s) under test.	FAA Order 6000.30C Section: 11e(4); FAA-E-2911 Section: 3.2.1c
3.3.4.1.2	Non-Interference MMC	b) The failure of any MMC function shall not degrade the NEXCOM System User Group communication.	FAA Order 6000.30C Section: 11e(4); FAA-E-2911 Section: 3.2.1c
3.3.4.1.2	Non-Interference MMC	c) NEXCOM MMC monitoring messages shall not prevent the communication or processing of NEXCOM MMC control messages.	FAA Order 6000.30C Section: 11e(4); FAA-E-2911 Section: 3.2.1c

SRD Section	SRD Title	Requirements	Source Document
3.3.4.2	MMC Access Security	a) The NEXCOM System shall provide at least 8 privilege levels for access to the NEXCOM MMC.	RD Section: 5.1.2; 7.2.1; 7.3.1.1; SRD Section: 3.2.4.2
3.3.4.4.1	Monitored Parameter Status	a) All data provided in response to maintenance or monitoring inquiries shall be less than 2 seconds old on average at the time of response, with a maximum of 4 seconds.	RD Section: 5.1.2; FAA-E-2911 Section: 3.2.3b
3.3.4.4.1	Monitored Parameter Status	b) The response shall be sent within 2 seconds average, 4 seconds maximum, after receipt of the inquiry. The time is measured from the time the managed subsystem receives the last byte of the data request to the time that the managed subsystem transmits the first byte of the response.	RD Section: 5.1.2; FAA-E-2911 Section: 3.2.3c
3.3.4.4.2	Alerting/Alarming	a) All data provided in alerts and alarms shall be less than 2 seconds old on average at the time of generation, with a maximum of 4 seconds.	RD Section: 5.1.2; FAA-E-2911 Section: 3.2.3b
3.3.4.4.3	MMC Data Logging	a) The NEXCOM System shall have 30 days of storage capacity for data logging entries to support diagnostics, and configuration management, without archival.	FAA-E-2911 Section: 3.2.1
3.3.4.4.3	MMC Data Logging	b) New data shall over-write the oldest unprotected data when the storage capacity is reached for non-archived data.	FAA-E-2911 Section: 3.2.1
3.3.4.4.3	MMC Data Logging	c) The NEXCOM System shall automatically archive log entries that are older than 25 days.	FAA-E-2911 Section: 3.2.1
3.3.4.4.3	MMC Data Logging	d) The NEXCOM System archival function shall not over-write existing log data.	RD Section: 5.1.2; 5.1.3
3.3.4.5	System Control Requirements	a) The NEXCOM Subsystem shall complete the task of executing a change of a MMC parameter command within 1 second average, 3 seconds maximum, after receiving the command.	RD Section: 5.1.2; FAA-E-2911 Section: 3.2.3d
3.3.4.5.1	Frequency Range	a) The NEXCOM System shall provide communications services in the range of 112 -137 MHz.	RD Section: 3.2.9.1; 5.3.2
3.3.4.5.1	Frequency Range	b) The NEXCOM System shall provide selectable lock out of the band from 112-117.975 MHz to prevent accidental tuning into the band prior to reallocation of portions of or the entire band for ATC use.	RD Section: 3.2.9.1; 5.3.2
3.3.4.5.2	RF Power Output	a) The RF output power of the NEXCOM System shall be adjustable from 2 to 50 watts (33 dBm to 47 dBm).	RD Section: 3.2.10.1; 6.3.1
3.3.4.7	System Startup	a) The NEXCOM System shall be operational within 5 minutes of applying power to the system components (subsystems).	SRD Section: 3.2.4.7

SRD Section	SRD Title	Requirements	Source Document
3.3.4.7	System Startup	b) Each NEXCOM Subsystem shall be operational within 5 minutes of applying power.	SRD Section: 3.2.4.7
3.3.4.9	General Data Interfaces	a) The NEXCOM System shall provide the three general data interfaces with a maximum communication rate possible according to the available bandwidth.	FAA-E-2885
3.3.4.9	General Data Interfaces	b) The general data interfaces shall not degrade system performance.	FAA-E-2885
3.3.4.9	General Data Interfaces	c) The failure of any general data interfaces shall not degrade the NEXCOM System User Group communication.	FAA-E-2885
3.3.5.1.1	Discrete I/O Utilization	a) The NEXCOM System shall provide an output state change within 500 ms of the state change at the input for 99.9% of the discrete I/Os state change events, when so configured.	SRD Section: 3.2.5.1.1; FAA-E-2885
3.3.5.1.1.1	Unused Interfaces	a) Internal and external interfaces, which are not required for operations, shall not degrade system operations or performance, regardless of whether they are activated or deactivated, open or terminated.	SRD Section: 3.3.5.1
3.3.5.1.1.1	Unused Interfaces	b) Unused interfaces, which are deactivated from operational use, shall not degrade system operations or performance, regardless of whether they are open or terminated.	SRD Section: 3.3.5.1
3.3.5.1.1.2	NEXCOM System Throughput	a) I/O throughput provided shall have room for future expansions.	RD Section: 3.2.14
3.3.5.1.1.2	NEXCOM System Throughput	b) The NEXCOM System shall operate with full occupancy of all voice and data slots.	RD Section: 3.2.12.1
3.3.5.2.1.1	Random Access Memory	a) The subsystems, as initially implemented, shall utilize less than 50% of the total available RAM.	RD Section: 3.2.14
3.3.5.2.1.2	Non-Volatile Memory	a) The subsystems, as initially implemented, shall utilize less than 50% of the total available non-volatile memory.	RD Section: 3.2.14
3.3.5.2.2	Processor Utilization	a) The utilization of all programmable processors and devices (e.g., Field Programmable Gate Arrays) shall not exceed 50 % of the maximum capacity of the device(s) as initially implemented.	RD Section: 3.2.14

SRD Section	SRD Title	Requirements	Source Document
3.3.6.1.1	Timing Accuracy	a) When the NEXCOM System is operating in VDL Mode 3 under normal operating conditions, the RF transmissions emanating from the NEXCOM System shall not be more than ±23.55 μs from their scheduled event time with respect to the Timing Standard specified in Section 3.3.6.3.	SRD Section: 3.3.6.3; Appendix G; RD Section: 3.2.2.1; Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.3.6.1.1	Timing Accuracy	b) When the NEXCOM System is operating in VDL Mode 3 with loss of the Timing Reference, the RF transmissions emanating from the NEXCOM System shall not be more than ±190 μs from their scheduled event time with respect to the Timing Standard specified in Section 3.3.6.3 and the Timing Drift period specified in Section 3.3.6.2.	SRD Section: 3.3.6.3; 3.3.6.3; Appendix G; RD Section: 3.2.2.1; Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.3.6.2	Timing Drift	a) With the loss of external Timing Reference conditioning, the Timing Source shall maintain system timing for at least 30 days without degrading system operation due to timing.	SRD Section: 3.3.6.1.1.d, Appendix G; RD Section: 3.2.2.1; Manual on VDL Mode 3 Technical Specifications 5.5; Manual on Implementation of VDL Mode 3 Section: 7, 8
3.3.6.3	Timing Standard	a) The Timing Source shall be aligned with UTC on 6 January 1980.	Manual on VDL Mode 3, Technical Specifications Section: 5.5.2.1.5
3.3.7.1.1	NEXCOM Mean Time Between Outages (MTBO)	a) The MTBO of the NEXCOM Subsystem at an RCAG shall be greater than or equal to 19,996 hours.	RD Section: 3.2.2.2
3.3.7.2.1	NEXCOM Mean Time to Restore (MTTR)	a) The NEXCOM RCAG MTTR, as defined by FAA Order 6040.15C, par. 702f, shall be less than or equal to 0.5 hours.	RD Section: 3.2.3.1; FAA Order 6040.15C, par. 702f
3.3.7.2.2	Periodic Maintenance	a) The equipment shall require on-site periodic maintenance no more than once per year.	RD Section: 3.2.5.1; 3.2.5.2; 3.2.5.3
3.3.7.2.2	Periodic Maintenance	b) Periodic maintenance tasks shall require no more than one person to accomplish.	RD Section: 3.2.5.1; 3.2.5.2; 3.2.5.3

SRD Section	SRD Title	Requirements	Source Document
3.3.7.2.2	Periodic Maintenance	c) Time to complete periodic maintenance tasks shall be equal to or less than existing equipment and require no more than 12 staff hours per year in accordance with NAS-SS-1000, Volume I, par. 3.2.3.2.	RD Section: 3.2.5.1; 3.2.5.2; 3.2.5.3; NAS-SS-1000, Volume I, par. 3.2.3.2
3.3.7.3.1	Voice Service Availability	a) The NEXCOM voice service availability, as defined by FAA Order 6040.15, par. 702c, shall be 0.99999 or greater.	RD Section: 3.2.4.1; FAA Order 6040.15, par. 702c
3.3.7.3.2	Data Service Availability	a) The NEXCOM data service availability, as defined by FAA Order 6040.15, par. 702c, shall be 0.99999 or greater.	NAS-SR-1000, 3.8.1c; FAA Order 6040.15, par. 702c
3.3.7.3.3	Equipment Availability	a) The NEXCOM System equipment shall have an inherent availability of .999975 or greater in accordance with NAS-SS-1000, Volume I, par. 3.2.4.	RD Section: 3.2.4.2; NAS-SS-1000, V1, Section 3.2.4
3.4.1.1	MDR Sustainment Operation	a) The NEXCOM MDR subsystems shall meet the functional requirements specified in the following: 1. FAA-P-2883, Purchase Description, VHF/UHF Air/Ground Communications Receiver 2. FAA-P-2884, Purchase Description, VHF/UHF Air/Ground Communications Transmitter	FAA-P-2883; FAA-P-2884
3.4.1.2	MDR Subsystem Functions	a) The MDR transmitter subsystems shall provide the functions listed in Table 3-4.	SRD Section: 3.2.2.1; RTCA DO-224a
3.4.1.2	MDR Subsystem Functions	b) The MDR receiver subsystem shall provide the functions listed in Table 3-5.	SRD Section: 3.2.2.1; RTCA DO-224a
3.4.1.3	MDR Subsystem Interfaces	a) The MDR transmitter and MDR receiver units shall have the following interfaces: 1. MDR/RIU Digital interface 2. MDR/MDT interface 3. MDR/RCE interface 4. MDR/Antenna interface 5. MDR/MDR RF-to-RF interface	RD Section: 5.1.3; SRD Section: 3.2.2; FAA-E-2885
3.4.1.4	MDR Human Interfaces	a) Each MDR transmitter shall include an on/off power switch.	RD Section: 6.1.1; 6.1.2
3.4.1.4	MDR Human Interfaces	b) Each MDR transmitter shall include a front panel display of the frequency, equipment state, and mode of operation.	RD Section: 6.1.1; 6.1.2
3.4.1.4	MDR Human Interfaces	c) Each MDR receiver shall include an on/off power switch.	RD Section: 6.1.1; 6.1.2
3.4.1.4	MDR Human Interfaces	d) Each MDR receiver shall include a front panel display of the frequency, equipment state, and mode of operation.	RD Section: 6.1.1; 6.1.2

SRD Section	SRD Title	Requirements	Source Document
3.4.1.5	MDR System Timing	a) The MDR shall derive all necessary VDL Mode 3 TDMA timing using the information received from the RIU.	SRD Section: 3.3.6.1.1
3.4.1.6	MDR Reliability/Maintainability	a) The MDR shall support critical services per NAS-SR-1000 Section 3.8.1, for voice and data.	SRD Section: 3.2.7.1; NAS-SR-1000
3.4.2.1.1	RIU Physical Layer Functions	a) The RIU shall encode and decode Reed-Solomon (72, 62) codewords for VDL Mode 3 data burst operation per RTCA DO-224A, Section 3.3.1.3.3.3.	SRD Section: 3.2.2.1; RTCA DO-224A Section: 3.3.1.3.3.3
3.4.2.1.2	RIU Media Access Control (MAC) Functions	a) The RIU shall implement the ground portion of the VDL Mode 3 MAC sublayer for voice, data and management functions as defined in RTCA DO-224A Section 3.3.2.1, except for requirements related to system configurations 3T, 3S and 2S1X.	SRD Section: 3.2.2.1; RTCA DO-224A Section: 3.3.2.1
3.4.2.1.2	RIU Media Access Control (MAC) Functions	b) The RIU MAC sublayer shall be upgradeable to support all other VDL Mode 3 system configurations.	SRD Section: 3.2.2.1
3.4.2.1.3	RIU Subsystem VDL Mode 3 DLS (Data Link Service) Functions	a) The RIU shall provide the (Data Link Service) DLS Acknowledgment (ACK) processing and priority queuing functions as defined in RTCA DO-224A, Section 3.3.2.2.	SRD Section: 3.2.2.1, 3.2.1.5; RTCA DO-224A Section 3.3.2.2
3.4.2.1.3	RIU Subsystem VDL Mode 3 DLS Functions	b) The RIU shall perform error detection and address identification (ID) on all DLS frames received from an MDR receiver as defined in RTCA DO-224A, Section 3.3.2.2.1.	SRD Section: 3.2.2.1, 3.2.1.5; RTCA DO-224A Section: 3.3.2.2.1
3.4.2.1.4	RIU Link Management Entity (LME) Functions	a) The RIU shall provide the following LME functions as defined in RTCA DO-224A, Section 3.3.2.3 for all VDL Mode 3 system configuration except 3T, 3S, and 2S1X: 1. Net Initialization 2. Net Entry 3. Link Maintenance (e.g., polling) 4. Link Release 5. Expedited Recovery	SRD Section: 3.2.2.1, 3.2.1.5; RTCA DO-224A Section: 3.3.2.3
3.4.2.1.4	RIU Link Management Entity (LME) Functions	b) The RIU LME shall be upgradeable to support all other VDL Mode 3 system configurations.	SRD Section: 3.2.2
3.4.2.2.1.1.1	RIU Subsystem PCM Voice Operation	a) The RIU shall use Pulse Code Modulation (PCM) to communicate audio with the MDR transmitter and receiver for DSB-AM modes of operation.	SRD Section: 3.2.2.2

SRD Section	SRD Title	Requirements	Source Document
3.4.2.2.1.1.2	RIU Subsystem Vocoder Operation	a) The RIU shall vocode audio between the GNI and the DSB-AM transmitter and receiver.	SRD Section: 3.2.2.1
3.4.2.2.1.1.2	RIU Subsystem Vocoder Operation	b) The RIU shall support both normal voice and downlink truncated voice data rates.	SRD Section: 3.2.2.1
3.4.2.2.1.1.3	Simultaneous Downlink UHF/VHF Voice	a) When the RIU is supporting DSB-AM modes of operation for VHF, the RIU shall conference/sum audio received from the selected and unmuted VHF and UHF receivers.	SRD Section: 3.2.2
3.4.2.2.1.1.3	Simultaneous Downlink UHF/VHF Voice	b) When downlink activity is present on both VHF and UHF Talk Groups, the RIU shall be configurable to communicate both audio conversations to the GNI.	SRD Section: 3.2.2
3.4.2.2.1.1.3	Simultaneous Downlink UHF/VHF Voice	c) If a downlink UHF voice reception begins while a downlink VDL Mode 3 voice reception is in progress, the RIU shall notify the GNI of the UHF reception and drop the UHF reception until the VDL Mode 3 downlink voice reception terminates.	SRD Section: 3.2.2
3.4.2.2.1.1.3	Simultaneous Downlink UHF/VHF Voice	d) If a downlink VHF VDL Mode 3 voice reception begins while a downlink UHF voice reception is in progress, the RIU shall send the Mobile User ID associated with the VDL Mode 3 reception to the GNI and drop the VDL Mode 3 voice reception until the UHF downlink voice reception terminates.	SRD Section: 3.2.2
3.4.2.2.1.2.1	RIU Subsystem VDL Mode 3 Data Operation	a) For VDL Mode 3 data operation, the RIU shall schedule data access per the Manual for the Implementation of VDL Mode 3, Section 4.9.	Manual for the Implementation of VDL Mode 3: Section 4.9.
3.4.2.2.1.2.1	RIU Subsystem VDL Mode 3 Data Operation	b) The RIU shall provide means whereby the maintenance personnel can prevent the use of the Main or Standby resources for data operation.	SRD Section: 3.2.4.1.1
3.4.2.2.1.2.1	RIU Subsystem VDL Mode 3 Data Operation	c) Upon enabling or disabling of the maintenance restriction of b), the RIU shall maintain data flow without interruption.	SRD Section: 3.2.4.1.1
3.4.2.3	RIU Local Maintenance, Monitoring and Control	a) The RIU shall interface to a local Maintenance Data Terminal to allow local control of the RIU.	SRD Section: 3.2.4.2, 3.2.4.2.1
3.4.2.3	RIU Local Maintenance, Monitoring and Control	b) The RIU shall allow the locally connected MDT to remotely control all attached MDRs and all attached UHF radios.	SRD Section: 3.2.4

SRD Section	SRD Title	Requirements	Source Document
3.4.2.3	RIU Local Maintenance, Monitoring and Control	c) The RIU shall only accept local control commands from an authenticated MDT.	RD Section: 7.2.1; 7.3.1.1
3.4.2.3	RIU Local Maintenance, Monitoring and Control	d) The RIU shall support the MDT's multidrop RIU access per Section 3.4.5.2 b).	FAA-E-2885
3.4.2.3	RIU Local Maintenance, Monitoring and Control	e) The RIU shall allow monitoring of its User Group resources in the GNI and at its backup sites, from its MDT port.	SRD Section: 3.2.4
3.4.2.3.1	RIU Front Panel Control and Monitoring	a) The RIU shall provide front-panel access to limited MMC capabilities to include: 1. Local Audio provision with independent volume control and slot selection 2. Status and Configuration Display	RD Section: 6.1.1; 6.1.2
3.4.2.3.2	RIU Telecommunications Monitoring	a) The RIU shall inhibit RF transmissions upon detection of the loss of telecommunications service.	SRD Section: 3.2.4.4.1
3.4.2.4	RIU Subsystem Interfaces	a) The RIU shall have the following interfaces: 1. RIU/Analog Radio Interface (see Section 3.4.2.4.6) 2. RIU/MDR Digital Interface (see Section 3.4.2.4.7) 3. RIU/MDT Interface (see Section 3.4.2.3) 4. RIU/Timing Source Interface (see Note) 5. RIU/Communication Link interface to GNI (see Section 3.4.2.4.1) 6. RIU/GNI Interface (see Section 3.4.3.4.2) 7. General Data Interface (see Section 3.4.2.4.3) 8. Human Interface (see Section 3.4.2.4.4) 9. Power Interface (see Section 3.4.2.4.5)	RD Section: 5.1.3; SRD Section: 3.2.2; FAA-E-2885
3.4.2.4.1	RIU/Telecommunications Interfaces	a) The RIU shall interface with at least a 56 kbps digital service via a DDC interface to access the remote GNI.	SRD Section: 3.2.3.8.1
3.4.2.4.1	RIU/Telecommunications Interfaces	b) The RIU shall support usage of analog 4-wire VG-6 ground telecommunications circuits to access the remote GNI when the digital interface is not being used.	RD Section 4.10.2; SRD Section: 3.2.3.8.1

SRD Section	SRD Title	Requirements	Source Document
3.4.2.4.1	RIU/Telecommunications Interfaces	c) The RIU shall support usage of analog 4-wire VG-8 ground telecommunications circuits to access the remote GNI when the digital interface is not being used.	RD Section: 4.10.2; SRD Section: 3.2.3.8.1
3.4.2.4.1	RIU/Telecommunications Interfaces	d) The RIU shall support telecommunications interfaces to provide dual control over redundant telecommunications links.	RD Section: 10.2.1; 10.2.1.2
3.4.2.4.1	RIU/Telecommunications Interfaces	e) When configured for standby telecommunications backup, the RIU shall detect transmission path failures (defined as an inability to communicate with a GNI for a 1 second period), causing a switch to an alternate transmission path to restore communications to the GNI.	FAA-E-2885 Section: 3.2.2.4
3.4.2.4.1	RIU/Telecommunications Interfaces	f) When conFigured for hot telecommunications backup with a GNI, the RIU shall simultaneously communicate over the redundant telecommunications interfaces with that GNI.	SRD Section: 3.2.3.8.2.2
3.4.2.4.1	RIU/Telecommunications Interfaces	g) When configured for hot telecommunications backup with a GNI, the RIU shall be able to use information from either interface without interfering with the operation of the communications system.	SRD Section: 3.2.3.8.2.2
3.4.2.4.1	RIU/Telecommunications Interfaces	h) When configured for standby telecommunications backup with a GNI, the RIU shall communicate over at least one telecommunications interface with that GNI.	SRD Section: 3.2.3.8.2.2
3.4.2.4.2	RIU/GNI Interfaces	a) For dual control, the RIU shall interface with two GNIs via RIU/Telecommunications interface(s) and/or direct connectivity.	SRD Section: 3.2.3.6.7
3.4.2.4.3	General Data Interfaces	a) The RIU shall provide at least three RS-232 serial communications interfaces for general data interfaces to external devices.	FAA-E-2885
3.4.2.4.3	General Data Interfaces	b) These general data streams shall have a lower priority than voice, data, or MMC.	FAA -E-2885
3.4.2.4.4	RIU Human Interfaces	a) The RIU shall include an on/off power switch.	RD Section: 6.1.1; FAA Human Factors Design Guide
3.4.2.4.4	RIU Human Interfaces	b) The RIU shall include a front panel display of the frequencies for each associated radio, system configuration, equipment state, and mode of operation of the RIU.	RD Section: 6.1.1; FAA Human Factors Design Guide
3.4.2.4.5	Power Interfaces	a) The RIU shall interface with existing power in NAS facilities consistent with FAA Order 6950.2D.	RD Section: 4.9.1; SRD Section: 3.3.1.1.1
3.4.2.4.6	RIU Analog Radio Interfaces	a) The RIU shall interface with up to four channels of existing analog UHF radio equipment, including Main/Standby Transmitter/Receiver units.	FAA-P-2883; FAA-P-2884

SRD Section	SRD Title	Requirements	Source Document
3.4.2.4.6	RIU Analog Radio Interfaces	b) The RIU shall use the digital audio signal from the GNI to drive the audio input of the analog voice radios.	SRD Section: 3.2.2.2; 3.2.2.3
3.4.2.4.6	RIU Analog Radio Interfaces	c) The RIU shall provide connections to each of the UHF radio's RMMC ports.	RD Section: 5.1.2
3.4.2.4.7	RIU/MDR Digital Interfaces	a) An RIU shall support up to two MDR transmitters and two MDR receivers.	SRD Section 3.2.1.1.1
3.4.2.5	Signaling	a) The RIU shall mute the received audio of the UHF and/or VHF radios when so commanded.	SRD Section: 3.2.3.6.4
3.4.2.5	Signaling	b) The RIU shall be configurable to either pass through an MDR generated PTT/PTT Release Confirmation signal or generate the signal locally per c).	RD Section: 3.1.1.4
3.4.2.5	Signaling	c) The RIU shall utilize the receiver to loop back the transmitted audio to determine the RIU-generated PTT/PTT Release Confirmation signal.	RD Section 3.17.1; SRD Section: 3.2.3.6.1
3.4.2.5	Signaling	d) The RIU shall use the End of Message (EOM) bit or lack of voice messages to indicate Squelch Break inactive, while operating in VDL Mode 3.	RD Section 3.17.1; SRD Section: 3.2.3.6.1
3.4.2.5	Signaling	e) The RIU shall use signaling information from the GNI to select the active MDR and UHF radio units.	RD Section: 3.1.1.4; SRD Section: 3.2.3.6.3
3.4.2.5	Signaling	f) When any PTT is activated, the RIU shall inhibit the main/standby (M/S) select function for that frequency (i.e., inhibit the re-routing of the voice and control signals and inhibit the switching of the antenna transfer relay).	FAA-E-2885; SRD Section: 3.2.3.6.5.1
3.4.2.5	Signaling	g) When the RIU is operating in Dual Control mode and when one user gains access at the RIU, the RIU shall pass a Lockout signal back to the other user's GNI to indicate when access to the RIU is not available.	SRD Section: 3.2.3.6.5.1e
3.4.2.6	RIU Reliability/Maintainability	a) The RIU shall support critical services per NAS-SR-1000 Section 3.8.1, for voice and data.	NAS-SR-1000; SRD Section: 3.2.7.1; 3.2.7.2; 3.2.7.3
3.4.2.7	RIU Site Configuration	a) The RIU shall support a configuration with a common RIU supporting the transmitters and receivers associated with a User Group.	SRD Section 3.2.1.1.1
3.4.2.7	RIU Site Configuration	b) To support separated transmitter and receiver sites, the RIU subsystem shall support a split-RIU configuration where RIU devices are located at each of the separated sites.	SRD Section 3.2.1.1.1

SRD Section	SRD Title	Requirements	Source Document
3.4.2.8	RIU System Timing Source	a) The RIU shall provide timing to the MDR transmitters and receivers.	SRD Section: 3.3.6.1.1
3.4.2.8	RIU System Timing Source	b) The RIU shall provide timing to the GNI.	SRD Section: 3.3.6.1.1
3.4.2.8	RIU System Timing Source	c) The RIU shall report the status of the Timing Source to the MMC function.	SRD Section: 3.3.6.1.1
3.4.3.2.1	Air/Ground Voice and Data	a) The GNI shall multiplex voice and data for transmission to the appropriate ground station RIU.	RD Section: 3.1.9.1; Attachment 2 par.6 Simultaneous Access to Voice and Data Communications
3.4.3.2.1.1	GNI Subsystem Voice Operation	a) The GNI shall encode/decode speech using the vocoder specified in ICAO Annex 10, Vol. III, Part 1, Chapter 6, for each Talk Group.	RD Section: 3.2.6.1; 5.4.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	a) The GNI shall provide VDL Mode 3 Packet Layer Protocol (PLP) compression, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3 and appendix J.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	b) The GNI shall provide CLNP frame mode compression, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3, and appendix K.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	c) The GNI shall provide raw subnetwork interface data transfer services for non-ATN messaging, as defined in RTCA DO-224A, Section 3.3.3.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	d) The GNI shall provide IEC/ISO 8208 data transfer services, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	e) The GNI shall provide CLNP data transfer services, as requested by Mobile Users, as defined in RTCA DO-224A, Section 3.3.3.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	f) The GNI shall be upgradeable to provide ATN Frame Mode subnetwork interface data transfer services, as requested by Mobile Users, as defined in Change 1 to RTCA DO-224A, Section 3.3.3.	RD Section: 5.4.1; SRD Section: 3.2.2.1
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	g) The GNI shall provide MbB services as defined in RTCA DO-224A, Section 3.3.3.3.	RD Section: 5.4.1; SRD Section: 3.2.2.1

SRD Section	SRD Title	Requirements	Source Document
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	h) The GNI group shall report to the A/G Router only those connectivity changes to the subnetwork that affect A/G Router connectivity decisions, as defined in RTCA DO-224A, Section 3.3.2.3.	RD Section: 5.4.1; SRD Section: 3.2.3.4.3
3.4.3.2.1.2.1	VDL Mode 3 Data Operation	i) The GNI shall not permit any of its functions or components to be used to access unauthorized parts of the NAS external to the NEXCOM System.	RD Section: 7.2.1; 7.3.1.1; Attachment 2 par.15 Information Security
3.4.3.3.1	GNI Subsystem Remote Monitoring Functions	a) The GNI shall monitor the functional status of its associated RIUs.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.1	GNI Subsystem Remote Monitoring Functions	b) The GNI shall monitor the functional status of its associated Timing Sources.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.1	GNI Subsystem Remote Monitoring Functions	c) The GNI shall monitor the functional status of its associated MDRs.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.1	GNI Subsystem Remote Monitoring Functions	d) The GNI shall monitor the functional status of its associated UHF radios.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.1	GNI Subsystem Remote Monitoring Functions	e) The GNI shall support monitoring of the port status of its A/G Router(s).	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.2	GNI Subsystem Remote Control Functions	a) The GNI shall support remote control of its associated RIUs.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.2	GNI Subsystem Remote Control Functions	b) The GNI shall support remote control of its associated MDRs.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.2	GNI Subsystem Remote Control Functions	c) The GNI shall support remote control of its associated UHF radios.	RD Section: 3.3.3; 5.1.3; SRD Section: 3.2.4.4.1
3.4.3.3.2	GNI Subsystem Remote Control Functions	d) The GNI shall coordinate operation of primary and backup site radio strings for a given User Group.	FAA-E-2885
3.4.3.4.1	GNI/Telecommunications Interfaces	a) The GNI shall interface with at least a 56 kbps digital service via a DDC interface to access the remote RIU.	SRD Section: 3.2.3.8.1
3.4.3.4.1	GNI/Telecommunications Interfaces	b) The GNI shall support usage of analog 4-wire VG-6 ground telecommunications circuits to access the remote RIU when the digital interface is not being used.	RD Section: 4.10.2; SRD Section: 3.2.3.8.1
3.4.3.4.1	GNI/Telecommunications Interfaces	c) The GNI shall support usage of analog 4-wire VG-8 ground telecommunications circuits to access the remote RIU when the digital interface is not being used.	RD Section: 4.10.2; SRD Section: 3.2.3.8.1
3.4.3.4.1	GNI/Telecommunications Interfaces	d) The GNI shall support redundant telecommunications interfaces for each RIU per Section 3.2.3.8.1.e).	SRD Section: 3.2.3.8.1e

SRD Section	SRD Title	Requirements	Source Document
3.4.3.4.1	GNI/Telecommunications Interfaces	e) When configured for standby telecommunications backup, the GNI shall detect transmission path failures (defined as an inability to communicate with an RIU for a 1 second period), switch to an alternate transmission path, and restore communications to the RIU.	FAA-E-2885, Section: 3.2.2.4
3.4.3.4.1	GNI/Telecommunications Interfaces	f) When configured for hot telecommunications backup with an RIU, the GNI shall simultaneously communicate over the redundant telecommunications interfaces with that RIU.	SRD Section: 3.2.3.8.2
3.4.3.4.1	GNI/Telecommunications Interfaces	g) When configured for hot telecommunications backup with an RIU, the GNI shall be able to use information from either interface without interfering with the operation of the communications system.	SRD Section: 3.2.3.8.2
3.4.3.4.1	GNI/Telecommunications Interfaces	h) When configured for standby telecommunications backup with an RIU, the GNI shall communicate over at least one telecommunications interface with that RIU.	FAA-E-2885 Section: 3.2.2.4
3.4.3.4.2	GNI/RIU Interfaces	a) The GNI shall interface with RIUs via the GNI/Telecommunications interface.	SRD Section: 3.2.3.8.1
3.4.3.4.2	GNI/RIU Interfaces	b) The GNI shall be scalable in the number of RIUs that may be supported.	RD Section: 3.2.14.1; 3.2.15.1
3.4.3.4.2	GNI/RIU Interfaces	c) The GNI shall support a configuration with separate RIUs for separated transmitters and receivers.	SRD Section: 3.2.1.1.1
3.4.3.4.3	GNI General Purpose Interfaces	a) The GNI shall provide at least 3 RS-232 data connections per RIU supported.	FAA-E-2885
3.4.3.4.3	GNI General Purpose Interfaces	b) The general data streams shall have a lower priority than voice, data, or MMC.	FAA-E-2885
3.4.3.4.4	GNI Human Interfaces	a) The GNI shall indicate the operational voice activity of each voice circuit to the front panel.	RD Section 3.1.1.4; FAA-E-2885
3.4.3.4.4	GNI Human Interfaces	b) The GNI shall indicate the status of each thread to the front panel.	RD Section 3.1.1.4; FAA-E-2885
3.4.3.4.4	GNI Human Interfaces	c) The GNI shall be configurable only from the NEXCOM/NIMS interface and the MMCWS.	RD Section 5.1.2; 7.2.1; 7.3.1.1
3.4.3.4.5	Power Interfaces	a) The GNI shall interface with existing critical power in NAS facilities consistent with FAA Order 6950.2D.	SRD Section: 3.2.1.1.2; FAA Order 6950.2D; RD Section: 3.2.1.1; 3.2.1.2

SRD Section	SRD Title	Requirements	Source Document
3.4.3.4.5	Power Interfaces	b) The GNI shall comply with requirements of the critical power bus.	SRD Section: 3.2.1.1.2; FAA Order 6950.2D; RD Section: 3.2.1.1; 3.2.1.2
3.4.3.4.5	Power Interfaces	c) The GNI shall continue to operate at least twenty minutes after the loss of critical power.	FAA Order 2914; RD Section: 3.2.1.1; 3.2.1.2
3.4.3.4.6	GNI/VSCE Interfaces	a) The GNI shall interface with existing VSCE (e.g., VSCS, ETVS, ICSS, RDVS, STVS) via existing interfaces (e.g., Single channel (V+U) and quad channel (V/U/M/S)).	FAA-E-2885
3.4.3.4.6	GNI/VSCE Interfaces	b) The GNI shall interface with voice switches via a common digital interface.	RD Section 3.1.9.1;3.2.14.1
3.4.3.4.7	GNI/Router Interfaces	a) A GNI shall interface with an A/G router via a GNI Data Switch function, per Appendix B.4.	RD Att 2 par 7 ATN Compatibility; SRD Section: B.4
3.4.3.4.7	GNI/Router Interfaces	b) A GNI shall interface with at least two different A/G routers.	SRD App E; RD Att 2 par 7 ATN Compatibility
3.4.3.4.8	GNI/GNI Interfaces	a) The GNI Data Switch function shall merge data communication paths from GNIs to an A/G router.	SRD Section: 3.2.2.1; 3.3.3.2.1.2; RD Att 2 par 7 ATN Compatibility
3.4.3.4.8	GNI/GNI Interfaces	b) The GNI Data Switch function shall be used to interconnect GNIs.	SRD Section: 3.2.2.1; 3.3.3.2.1.2; RD Att 2 par 7 ATN Compatibility
3.4.3.4.8	GNI/GNI Interfaces	c) GNIs from adjacent control facilities shall coordinate handoffs of Mobile User between these facilities.	SRD Section: 3.2.2.1; 3.3.3.2.1.2; RD Att 2 par 7 ATN Compatibility
3.4.3.4.8	GNI/GNI Interfaces	d) The GNI shall support at least two paths for GNI interconnections.	SRD App E; RD Att 2 par 7 ATN Compatibility
3.4.3.4.9	GNI/Automation Interfaces	a) The GNI shall interface with the automation system to receive Next Channel Uplink information.	SRD Section: 3.2.2.1
3.4.3.4.9	GNI/Automation Interfaces	b) The GNI shall receive confirmation from the radio site as to the success of the uplink of the Next Channel Uplink information.	SRD Section: 3.2.2.1
3.4.3.4.9	GNI/Automation Interfaces	c) The GNI shall present to the automation system the confirmation signal on success of the Next Channel Uplink transmission.	SRD Section: 3.2.2.1
3.4.3.4.9	GNI/Automation Interfaces	d) The GNI shall provide indication to the automation system of the login status of Mobile User.	SRD Section: 3.2.2.1

SRD Section	SRD Title	Requirements	Source Document
3.4.3.4.9	GNI/Automation Interfaces	e) The GNI shall provide indication to the automation system of the Talker ID (Mobile User Identity) of the Mobile User communicating on the voice channel for VDL Mode 3.	SRD Section: 3.2.2.1
3.4.3.4.9	GNI/Automation Interfaces	f) The GNI shall provide indication to the automation system of received Urgent Downlink Requests for VDL Mode 3.	SRD Section: 3.2.2.1
3.4.3.4.10	GNI/MMCWS Interface	a) Each GNI shall interface to the collocated MMC Workstation.	RD Section: 5.1.3
3.4.3.5	Signaling	a) The GNI shall pass the signaling indicated in Section 3.4.2.5 e) from the VSCE to the RIU.	SRD Section: 3.4.2.8; 3.2.3.1.1; FAA-E-2885
3.4.3.5	Signaling	b) The GNI shall pass the signaling from the RIU to the VSCE as indicated in Section 3.4.2.5 b), d), and g).	FAA-E-2885; SRD Section: 3.4.2.8
3.4.3.6	GNI Reliability/Maintainability	a) The GNI shall support critical services per NAS-SR-1000 Section 3.8.1, for voice and data.	NAS-SR-1000; SRD Section: 3.2.7.1
3.4.3.6.1	GNI Redundancy	a) The failure of any thread(s) within the GNI to its RIU shall not degrade communications of any other GNI/RIU threads.	RD Section 3.2.1.2
3.4.3.6.1	GNI Redundancy	b) A failure within a GNI shall not cause loss of communications within a User Group.	RD Section: 3.2.1.2; SRD Appendix E
3.4.3.6.1	GNI Redundancy	c) Failure of a single GNI thread shall not cause loss of A/G communications services.	RD Section: 3.2.1.2
3.4.4.1	A/G Routing	a) The A/G Router shall implement air/ground routing protocols as per ICAO Document 9705.	RD Section: 3.1.9.1; Att 2 par 7 ATN Compatibility
3.4.4.1	A/G Routing	b) Each A/G router shall be located at an ARTCC.	SRD Section: 3.3.3.2.1.2; 3.3.3.2.1.1
3.4.4.1	A/G Routing	c) Each A/G router shall be responsible for providing the ATN subnetwork services to the GNI(s) within its domain.	SRD Section: 3.3.3.2.1.2; 3.3.3.2.1.1
3.4.4.1	A/G Routing	d) The A/G Router shall conform to FAA routing policies.	SRD Section: 3.3.3.2.1.2; 3.3.3.2.1.1
3.4.4.1.1.1	SNDCF for ISO/IEC 8208 Mobile Subnetworks	a) The A/G Router shall implement the SNDCF for ISO/IEC 8208 Mobile Subnetworks per ICAO Document 9705, as an interface to the VDL Mode 3 PLP Compressor.	SRD Section: 3.2.2.1; ICAO Doc 9705
3.4.4.1.1.2	SNDCF for Frame Mode Mobile Subnetworks	a) The A/G Router shall be upgradeable to implement the SNDCF for Frame Mode Mobile Subnetworks per ICAO Document 9705, as an interface to the ATN Frame Mode Compressor.	SRD Section: 3.2.2.1; ICAO Doc 9705

SRD Section	SRD Title	Requirements	Source Document
3.4.4.1.1.3	SNDCF for VDL Mode 3 Frame Mode Mobile Subnetworks	a) The A/G Router shall implement the SNDCF for VDL Mode 3 Frame Mode Mobile Subnetworks per ICAO Document 9705, as an interface to the CLNP Frame Mode Compressor.	SRD Section: 3.2.2.1; ICAO Doc 9705
3.4.4.2.1	Local MMC	a) The A/G Router shall provide local configuration, monitoring and control for the router.	SRD Section: 3.2.4.4.1; 3.2.4.5; 3.2.4.2
3.4.4.2.2	Remote MMC	a) The A/G Router shall provide remote MMC access to NIMS.	SRD Section: 3.2.4.2
3.4.4.3	A/G Router Reliability/Maintainability	a) The A/G Router subsystem shall provide at least two independent paths from the GNI to the ATN network.	SRD 3.2.7.1.1; App E; RD Att 2 par 7 ATN Compatibility
3.4.5	MDT Functional Requirements	a) The MDT shall provide a means for asserting the same operational functions normally available via the VSCE interface (e.g., Main, Standby, and BUEC transmitters and receivers selection, PTT, Mute, etc.) for each Talk Group(s) to which it is attached.	RD Section: 5.1.3; SRD Section: 3.2.4.2.1
3.4.5	MDT Functional Requirements	b) The MDT shall provide a means for monitoring the operational status of the User Group(s) to which it is attached.	RD Section: 5.1.3; SRD Section: 3.2.4.2.1
3.4.5.1	Local MMC	a) The NEXCOM MDT function shall use an existing NAS MDT to access local maintenance, monitoring and control functions of the RIU, and MDR.	SRD Section: 3.2.4.2
3.4.5.2	Remote MMC	a) When connected to an RIU, the NEXCOM MDT function shall access remote MMC information from all MDRs, and UHF radios that are attached to the RIU.	SRD Section: 3.2.4
3.4.5.2	Remote MMC	b) The NEXCOM MDT function shall access all RIUs at a facility from a common connection point.	FAA-E 2885
3.4.5.3	Logging	a) The MDT shall download and store the log files from the RIUs, and MDRs at a site.	SRD Section: 3.2.4.4.3
3.4.5.4	MDT Security	a) The MDT shall support the assignment of a unique logon identifier for each user.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	b) When passwords are to be used for authentication, the MDT shall use strong passwords (e.g., prevent the use of dictionary words).	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	c) The MDT shall enforce mandatory password changes at set intervals.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	d) The MDT shall prevent the reuse of passwords on a per user basis.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	e) The RIU/MDT shall implement Strong Authentication.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	f) The MDT shall enable access Authorization Management.	SRD Section: 3.2.4.2.3

SRD Section	SRD Title	Requirements	Source Document
3.4.5.4	MDT Security	g) The MDT shall enforce separation of duties through its role-based ability to restrict users to specific MMC functions and to specific actions on those functions.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	h) The MDT shall temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	i) The MDT shall display a configurable banner page upon login.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	j) The MDT shall protect NEXCOM information system security data from all unauthorized access.	SRD Section: 3.2.4.2.3
3.4.5.4	MDT Security	k) The MDT shall terminate control access to any subsystem after a configurable amount of control inactivity.	SRD Section: 3.2.4.2.3
3.4.6	Workstation Functional Requirements	a) The MMCWS shall provide a means for asserting the same operational functions normally available via the VSCE interface (e.g., Main, Standby, and BUEC transmitters and receivers, PTT, Mute, etc.) for each Talk Group(s) to which it is attached.	RD Section: 5.1.3; SRD Section: 3.2.4.2.1
3.4.6	Workstation Functional Requirements	b) The MMCWS shall provide a means for monitoring the operational status of the User Group(s) to which it is attached.	RD Section: 5.1.3; SRD Section: 3.2.4.2.1
3.4.6.1	Local MMC	a) The MMCWS shall be a control access point for local maintenance, monitoring and control functions of the GNI.	SRD Section: 3.2.4.2.1
3.4.6.2	Remote MMC	a) The MMCWS shall access remote MMC information from all connected RIUs.	SRD Section: 3.2.4.2.2
3.4.6.2	Remote MMC	b) The MMCWS shall access remote MMC information from all connected MDRs.	SRD Section: 3.2.4.2.2
3.4.6.2	Remote MMC	c) The MMCWS shall access remote MMC information from all connected UHF radios.	SRD Section: 3.2.4.2.2
3.4.6.2	Remote MMC	d) The MMCWS shall access remote MMC information from all connected A/G Routers.	SRD Section: 3.2.4.2.2
3.4.6.2	Remote MMC	e) The MMCWS shall monitor MMC information from the Data Link Application End System responsible for the GNI with which the MMCWS is associated.	SRD Section: 3.2.4.2.2
3.4.6.3	Logging	a) The MMCWS shall log all alerts and alarms from all NEXCOM Subsystems.	SRD Section: 3.2.4.4.2
3.4.6.3	Logging	b) The MMCWS shall log all MMC control commands sent to the NEXCOM Subsystems, except the A/G Router.	SRD Section: 3.2.4.4.2

SRD Section	SRD Title	Requirements	Source Document
3.4.6.3	Logging	c) The MMCWS shall log all access attempts to the MMC system.	SRD Section: 3.2.4.4.2
3.4.6.4	Platform Requirements	a) The MMCWS shall reside on platforms compatible with those already in the NAS, to include MDT platforms.	RD Section: 10.2.1.4
3.4.6.5	MMCWS Security	a) The MMCWS shall support the assignment of a unique logon identifier for each user.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	b) The MMCWS shall authenticate the claimed user's identity before allowing the user to perform any actions other than a well-defined set of operations.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	c) When passwords are to be used for authentication, the MMCWS shall use strong passwords (e.g., prevent the use of dictionary words).	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	d) The MMCWS shall enforce mandatory password changes at set intervals.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	e) The MMCWS shall prevent the reuse of passwords for 6 months on per user basis.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	f) The MMCWS shall implement strong authentication.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	g) The MMCWS shall enable access Authorization Management.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	h) The MMCWS shall enforce separation of duties through its role-based level to restrict users to specific MMC functions and to specific actions on those functions.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	i) The MMCWS shall temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	j) The MMCWS shall display a configurable banner page upon login.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	k) The MMCWS shall protect information system security data and functionality from all unauthorized access.	SRD Section: 3.2.4.2.3
3.4.6.5	MMCWS Security	l) The MMCWS shall terminate NEXCOM control access to any subsystem after a configurable amount of NEXCOM control inactivity.	SRD Section: 3.2.4.2.3
3.4.7.1	Time Conditioning	a) The Timing Source shall synchronize timing with the Timing Reference.	SRD Section: 3.2.6.1
3.4.7.1	Time Conditioning	b) The Timing Source shall provide timing to connected RIU(s).	SRD Section: 3.3.6.1.1
3.4.7.2	Timing Source Interfaces	a) The Timing Source shall interface with the Timing Reference.	SRD Section: .3.6.1.1d; 3.2.6.1c
3.4.7.2	Timing Source Interfaces	b) The Timing Source shall interface to collocated RIU(s).	SRD Section: 3.2.6.2a; 3.3.6.1.1

SRD Section	SRD Title	Requirements	Source Document
3.4.7.3	Status Monitoring	a) The Timing Source shall monitor the status of the Timing Reference.	SRD Section: 3.2.6.1; 3.2.6.2
3.4.7.3	Status Monitoring	b) The Timing Source shall provide status information concerning the Timing Reference to the RIU.	SRD Section: 3.2.4.4.1
3.5.1.1	MDR Sustainment Operation	a) The NEXCOM MDR subsystems shall meet the performance requirements specified in the following: 1. FAA-P-2883, Purchase Description, VHF/UHF Air/Ground Communications Receiver 2. FAA-P-2884, Purchase Description, VHF/UHF Air/Ground Communications Transmitter	FAA-P-2883; FAA-P-2884
3.5.1.2.2	Uplink Digital Voice Delay in MDR Transmitter	a) The uplink audio processing delay contribution of each MDR transmitter in digital voice modes shall be less than or equal to 6 ms, measured from the reception of the complete High-Level Data Link Control (HDLC) voice burst message containing vocoder frame 6 from the RIU to the time when the MDR begins RF transmission (referenced to the antenna port) of the first D8PSK symbol in vocoder frame 6.	SRD Section: 3.3.3.1.3.1
3.5.1.2.3	Uplink Analog Voice Delay in MDR Transmitter	a) The uplink audio processing delay contribution of each MDR transmitter in analog voice modes via the RIU/MDR Digital interface (using PCM audio) to the RIU shall be less than or equal to 9 ms, measured from the reception of the second complete RIU HDLC PCM voice message to the time when the MDR begins RF transmission (referenced to the antenna port) of the first PCM voice message.	SRD Section: 3.3.3.1.3.1
3.5.1.2.3	Uplink Analog Voice Delay in MDR Transmitter	b) In sustainment mode, the audio processing delay in the MDR transmitter, measured from the analog voice input port on the MDR transmitter to the transmitter antenna port, with the Push-to-Talk (PTT) signal line activated at the RCE/MDR interface, shall be less than 13 ms.	SRD Section: 3.3.3.1.3.1
3.5.1.2.4	Downlink Digital Voice Delay in MDR Receiver	a) The downlink audio processing delay contribution of the MDR receiver in digital voice modes shall be less than or equal to 17 ms, measured from the Time of Arrival of the last D8PSK symbol of the first vocoder frame in a VDL Mode 3 voice burst at the antenna port to the time when the MDR completes transmission of the HDLC voice burst message containing vocoder frame 1 to the RIU.	SRD Section: 3.3.3.1.3.2

SRD Section	SRD Title	Requirements	Source Document
3.5.1.2.5	Downlink Analog Voice Delay in MDR Receiver	a) The downlink audio processing delay contribution of the MDR receiver in analog voice modes via the RIU/MDR Digital interface (using PCM audio) to the RIU shall be less than or equal to 83 ms, measured from MDR receiver Squelch Break to the time when the MDR receiver completes transmission of the second HDLC PCM voice message to the RIU.	SRD Section: 3.3.3.1.3.2
3.5.1.2.5	Downlink Analog Voice Delay in MDR Receiver	b) In sustainment mode, the audio processing delay in the MDR receiver, measured from the RF signal received at the MDR receiver antenna port to the corresponding demodulated analog voice output of the receiver, shall be less than 13 ms.	SRD Section: 3.3.3.1.3.2
3.5.1.5	MDR System Timing	a) The time offsets for transmission of VDL Mode 3 voice, data or management burst messages shall not deviate by more than ±10 µs from the MDR's timing reference point.	SRD Section: 3.3.6.1.1
3.5.1.5	MDR System Timing	b) The time offsets for the reception window for VDL Mode 3 voice, data or management burst messages shall be accurate to within ±10 µs from the RIU's system time.	SRD Section: 3.3.6.1.1
3.5.1.6	MDR Reliability/Maintainability	a) The MDR transmitter and the MDR receiver shall have a combined MTBF equal to or greater than 26,280 operational hours.	RD Section: 3.2.2.1; SRD Section 3.3.7.1.1; App E
3.5.2.2.1.2.1	RIU/GNI Message Delays	a) The RIU shall complete the transmission of a valid DLS frame over the RIU/GNI telecommunications link no later than 500 ms after the last data burst message associated with the DLS frame is received from the MDR Receiver.	SRD Section: 3.2.2.1
3.5.2.2.1.2.1	RIU/GNI Message Delays	b) The RIU shall provide timing signals to the GNI to minimize end-end voice delay.	SRD Section: 3.3.6.1.1
3.5.2.4.1.1	Transmission Path Failure Restoration	a) For telecommunication service failures where a redundant path exists and the NEXCOM System is configured for standby telecommunications backup, the RIU shall restore communications to the GNI via the alternate path within 1 second.	SRD Section: 3.4.2.5, SRD 3.3.3.8.2.1.a; FAA-E-2885
3.5.2.4.1.1	Transmission Path Failure Restoration	b) For telecommunication service interruptions of less than 1 second in duration, the RIU shall restore communications to the GNI within 120 ms.	SRD Section: 3.4.2.5, 3.3.3.8.2.b; FAA-E-2885

SRD Section	SRD Title	Requirements	Source Document
3.5.2.4.1.1	Transmission Path Failure Restoration	c) For telecommunications service failures of greater than 1 second in duration where no redundant path exists, the RIU shall establish the connection for operational use within 3 seconds.	SRD Section: 3.4.2.5; FAA-E-2885
3.5.2.4.1.1	Transmission Path Failure Restoration	d) The RIU, when so configured, shall complete the switch back to the primary telecommunications link within 3 seconds after receiving the GNI switching command and PTT deactivation, without loss of data.	SRD Section: 3.4.2.5, 3.3.3.8.2.1.b
3.5.2.4.3	General Data Interfaces	a) The RIU shall interface at up to 9,600 bps on each of the general data interfaces.	FAA-E-2885; SRD Section: 3.3.4.9
3.5.2.4.3	General Data Interfaces	b) The RIU shall provide an aggregate rate of at least 1,200 bps for all of the general data interfaces.	SRD Section: 3.3.4.9
3.5.2.5.1	RIU Signaling Integrity	a) The RIU shall ensure that no more than one control signal in one million is falsely interpreted or not completed.	FAA-E-2885 Section: 3.2.3.2.1
3.5.2.6	RIU Reliability/Maintainability	a) The RIU MTBF shall be equal to or greater than 40,000 operational hours.	SRD Section: 3.3.7.1.1; App E
3.5.2.7	RIU Site Configuration	a) The RIU shall be located within 6,000 feet of the MDR transmitter to ensure proper timing of the MDR transmissions.	SRD Section: 3.4.2.4
3.5.3.2.1.2.1	GNI Data Processing Delay	a) The processing delay for multiplexing VDL Mode 3 voice and data of a GNI subsystem shall be less than 10 ms.	SRD Section: 3.4.3.4.1
3.5.3.2.1.2.1	GNI Data Processing Delay	b) MMC data processing shall not delay uplink or downlink voice and control data processing or distribution.	SRD Section: 3.4.3.4.1
3.5.3.2.1.2.2	GNI Connectivity Report Time	a) The GNI shall comply with connectivity reporting time requirements of ATSC Class B Service identified in Table 3-1.	SRD Section: 3.3.3.2.1.4
3.5.3.4.1.1	Transmission Path Failure Restoration	a) For telecommunication service failures where a redundant path exists and the NEXCOM System is configured for standby telecommunications backup, the GNI shall restore communications to the RIU via the alternate path within 1 second.	SRD Section: 3.3.3.8.2.1; FAA-E-2885 Section: 3.2.2.4
3.5.3.4.1.1	Transmission Path Failure Restoration	b) For telecommunication service interruption of less than 1 second in duration, the GNI shall restore communications to the RIU within 120 ms.	SRD Section: 3.3.3.8.2
3.5.3.4.1.1	Transmission Path Failure Restoration	c) For telecommunications service failures of greater than 1 second in duration where no redundant path exists, the GNI shall establish the connection for operational use within 3 seconds.	SRD Section: 3.4.3.1.2

SRD Section	SRD Title	Requirements	Source Document
3.5.3.4.1.1	Transmission Path Failure Restoration	d) The GNI shall complete the switch back to the primary telecommunications link in less than 3 seconds with no loss of data, after the primary link is restored and PTT is deactivated.	SRD Section: 3.4.3.1.2
3.5.3.4.2	GNI/RIU Interface	a) The GNI shall support a control facility that interfaces to at least 350 RIUs.	SRD Section: 3.3.4.4
3.5.3.4.3	General Data Interface	a) The GNI shall interface at up to 9,600 bps on each of the general data interfaces of Section 3.4.3.4.3.	SRD Section: 3.3.4.9
3.5.3.4.3	General Data Interface	b) The GNI shall provide an aggregate data rate of at least 1200 bps for all of the general data lines.	SRD Section: 3.3.4.9
3.5.3.5.1	GNI Signaling Integrity	a) The GNI shall ensure that no more than one control signal in one million is falsely interpreted or not completed.	FAA-E-2885 Section: 3.2.3.2.1
3.5.3.5.2.1	PTT/PTT Release	a) Based on VSCE PTT signaling, the RIU shall provide the PTT signal at the RIU/Analog Radio interface from 15 - 25 ms prior to the audio for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2: UHF Radio PD v0.6: Section 3.2.2.2.12 g
3.5.3.5.2.1	PTT/PTT Release	b) The response time from the instant the GNI receives a PTT/PTT Release signal from the VSCE, to the instant the RIU provides/removes PCM voice packets at the RIU/MDR interface shall not exceed 208 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.1	PTT/PTT Release	c) The response time from the instant the GNI receives a PTT/PTT Release signal from the VSCE, to the instant the RIU provides/removes VDL Mode 3 voice packets at the RIU/MDR interface shall not exceed 165 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.2	PTT/PTT Release Confirmation	a) The response time from the instant the RIU provides/removes the PTT/PTT Release signal at the RIU/Analog Radio interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.2	PTT/PTT Release Confirmation	b) The response time from the instant the RIU provides/removes the PCM voice bursts at the RIU/MDR interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2

SRD Section	SRD Title	Requirements	Source Document
3.5.3.5.2.2	PTT/PTT Release Confirmation	c) The response time from the instant the RIU provides/removes the VDL Mode 3 voice bursts at the RIU/MDR interface, to the instant that the GNI provides a PTT/PTT Release Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.3	Preemption of Mobile Users' Voice Transmission	a) The Voice Preemption signal shall be contained in the next scheduled uplink Beacon that occurs at least 50ms after the reception of the Voice Preemption and PTT signals from the NEXCOM/VSCE interface for 99.9% of the preemption events.	SRD Section: 3.2.3.6.3
3.5.3.5.2.4	Preemption of Mobile Users' Voice Transmissions Confirmation	a) The response time from the instant the Voice Preemption signal is generated at the RIU to the instant when the Voice Preemption confirmation signal is received at the NEXCOM/VSCE interface shall not exceed 340ms for 99.9% of the events.	SRD Section: 3.2.3.6.4
3.5.3.5.2.5	Squelch Break	a) The response time from the instant the Analog Radio provides/removes the Squelch Break signal at the RIU/Analog Radio interface, to the instant that the Squelch Break signal appears at the NEXCOM/VSCE interface shall not exceed 100 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.5	Squelch Break	b) The response time from the instant the MDR provides/removes voice bursts at the RIU/MDR interface, to the instant that the GNI provides a Squelch Break indication at the NEXCOM/VSCE interface shall not exceed 100 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.6.3	Commanded Mute/Unmute Confirmation	a) The response time from the instant the voice signal is muted/unmuted in the RIU to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.2.3.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.6.3	Commanded Mute/Unmute Confirmation	b) The response time from the instant the Commanded Mute/Unmute signal is available at the RIU/Analog Radio interface to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.2.3.1; SRD Section: 3.4.3.2.2

SRD Section	SRD Title	Requirements	Source Document
3.5.3.5.2.6.3	Commanded Mute/Unmute Confirmation	c) The response time from the instant the Commanded Mute/Unmute signal is available at the RIU/MDR interface to the instant the GNI provides the Commanded Mute/Unmute Confirmation signal at the NEXCOM/VSCE interface shall not exceed 340 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.2.3.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.7.1	Ground Radio Resource Selection	a) The response time from the instant the VSCE provides the Ground Radio Resource Selection (e.g., Main/Standby select/deselect or BUEC select/reset as necessary) signal at the NEXCOM/VSCE interface, to the instant the remote site RIU executes both of the following actions shall not exceed 100 ms for 99.9% of the events: 1. Switches to the selected main or standby transmitter/receiver, that is, routes the voice and control signals only to/from the selected transmitter/receiver 2. Provides the necessary signaling to the antenna transfer relay via the remote site RIU/Radio interface	FAA-E-2885 Section: 3.2.3.2.2.2; SRD Section: 3.4.3.2.2
3.5.3.5.2.7.2	Ground Radio Resource Selection confirmation	a) The response time from the instant the RIU completes Ground Radio Resource Selection actions (e.g., Main/Standby select/deselect or BUEC select/reset as necessary), to the instant the GNI provides a M/S Select/Deselect Confirmation signal at the NEXCOM/VSCE interface shall not exceed 250 ms for 99.9% of the events.	FAA-E-2885 Section: 3.2.3.2.2.2.1; SRD Section: 3.4.3.2.2
3.5.3.5.2.8	Dual Control VHF/UHF Lockout/Lockout Release	a) The response time from the instant the VHF/UHF Lockout/Lockout release condition is declared in the RIU to the instant when the GNI is notified of the VHF/UHF Lockout/lockout release condition shall not exceed 120ms for 99.9% of the events.	RD Section: 3.1.6.1; SRD Section: 3.4.3.2.2
3.5.3.6	GNI Reliability/Maintainability	a) The GNI MTBF shall be equal to or greater than 30,000 operational hours.	RD Section: 3.2.4.1; 3.2.4.3; SRD App E
3.5.4.1.1	A/G Router Capacity	a) Each A/G Router shall support at least 1000 Mobile Users.	SRD Section: 3.4.4.1
3.5.4.1.2	A/G Router Traffic Loading	a) The A/G Router shall process at least 1500 join events per hour.	SRD Section: 3.4.4.1
3.5.4.1.2	A/G Router Traffic Loading	b) The A/G Router shall process at least 1500 leave events per hour.	SRD Section: 3.4.4.1
3.5.4.1.2	A/G Router Traffic Loading	c) The A/G Router shall process at least 55 Network Protocol Data Units (NPDU) per second, each of 256 octets in length.	SRD Section: 3.4.4.1

SRD Section	SRD Title	Requirements	Source Document
3.5.4.3	A/G Router Reliability/Maintainability	a) The A/G Router MTBF shall be equal to or greater than 19,996 operational hours.	RD Section: 3.2.4.1; 3.2.4.3; SRD App E
3.5.6.1	MMCWS MTBF	a) The MMCWS MTBF shall be equal to or greater than 9,000 operational hours.	
3.5.7.2	Time Drift	a) With the loss of the external Timing Reference conditioning, the Timing Source shall maintain system timing for at least 30 days without degrading system operation due to timing.	SRD Section: 3.3.6.2a
3.5.7.3	Time Standard	a) The Timing Source shall be aligned with UTC on 6 January 1980.	SRD Section: 3.3.6.3
3.6.1.2.1	PTT/PTT Release Confirmation	a) The VSCE shall continually indicate to the controller transmit channel status via PTT confirmation.	RD Section: 3.1.1.4; 3.1.7.1
3.6.1.2.2	Preemption of Mobile Users' Voice Transmissions	a) The VSCE controller interface shall generate a Voice Preemption signal which in the presence of a PTT serves to terminate all PTT voice transmission within a Talk Group.	RD Section: 3.3.1; 3.3.2; RTCA DO-224A Section: 3.3.2.1.1
3.6.1.2.2	Preemption of Mobile Users' Voice Transmissions	b) The VSCE shall deliver the preemption signal to the NEXCOM System interface.	SRD Section: 3.2.3.6.3
3.6.1.2.3	Preemption Confirmation of Mobile Users' Voice Transmissions	a) The VSCE shall indicate to the controller the Voice Preemption Confirmation signal generated by the NEXCOM System.	SRD Section: 3.2.3.6.4
3.6.1.2.4	Squelch Break	a) The VSCE shall continually indicate to the controller Squelch Break status.	RD Section: 3.1.1.4; 3.1.7.1
3.6.1.2.5	Ground Radio Resource Selection Confirmation	a) The VSCE shall indicate to each controller the actual configuration of the equipment supporting that controller’s Talk Group based on feedback from the NEXCOM System.	RD Section: 3.1.1.4; SRD Section: 3.6.2.1
3.6.1.2.6	Channel Busy Signal	a) The VSCE shall provide an indication to the controller that the requested channel is occupied.	RD Section: 3.1.1.4; SRD Section: 3.6.2.2; RTCA DO-224A Section: 3.3.5.4.3
3.6.1.2.7	Channel Labeling	a) The VSCE A/G channel selector shall display six numerical characters in accordance with ICAO Annex 10, Vol. V, Ch. 4.	ICAO Annex 10, Vol. V, Ch. 4
3.6.2.1	Support for Voice, Data and Signaling	a) Telecommunications links shall support voice, data and signaling for the NEXCOM System.	SRD Section: 3.2.3.8.1

SRD Section	SRD Title	Requirements	Source Document
3.6.2.2	Telecommunications Interfaces	a) Telecommunications circuits shall interface via either 4-wire or DDC, as needed.	SRD Section: 3.2.3.8.1
3.6.2.3	Physical Path Diversity	a) Telecommunications link(s) shall provide at least one telecommunications circuit between an RIU and its associated GNI.	RD Section: 10.2.1; 10.2.1.2
3.6.2.3	Physical Path Diversity	b) Telecommunications link(s) shall provide diversity between telecommunications circuits for connectivity for selected A/G Communications sites, in accordance with FAA Order 6000.36A.	RD Section: 10.2.1; 10.2.1.2
3.6.2.4	Telecommunications Availability	a) Telecommunications shall support A/G voice and data service.	SRD Section: 3.2.3.8.1
3.6.3	NAS Infrastructure Management System (NIMS) Functional Requirements	a) The NIMS shall interface with the NEXCOM System via an interface compliant with FAA-E-2911 and the NEXCOM/NIMS Interface Control Document (ICD), NAS-IC-TBD.	RD Section: 5.1.2; 5.1.3
3.6.3	NAS Infrastructure Management System (NIMS) Functional Requirements	b) The NIMS shall provide a Computer Human Interface (CHI) for the Remote Maintenance Monitor functions of the NEXCOM System.	RD Section: 5.1.2
3.6.3	NAS Infrastructure Management System (NIMS) Functional Requirements	c) The NIMS shall assign for each NIMS user authorized to access the NEXCOM MMC for each associated pre-defined privilege level to the NEXCOM/NIMS interface.	RD Section: 5.1.2; 5.1.3
3.6.3	NAS Infrastructure Management System (NIMS) Functional Requirements	d) The NIMS shall provide mapping from the NIMS users to their associated privilege levels.	RD Section: 5.1.2; 5.1.3
3.6.3.1	NIMS/NEXCOM Interface	a) The NIMS interface to the NEXCOM System shall be located at the GNI.	SRD Section: 3.2.4.2.4; RD Section: 5.1.2; 5.1.3
3.6.3.1.1	Status Monitoring	a) The NIMS shall provide status monitoring of the NEXCOM (Sub)system(s), when authorized	RD Section: 5.1.2; 5.1.3
3.6.3.1.2	Control	a) The NIMS shall control the NEXCOM (Sub)system(s), when authorized.	RD Section: 5.1.2; 5.1.3
3.6.3.1.3	Performance Monitoring	a) The NIMS shall provide performance monitoring of the NEXCOM (Sub)system(s).	RD Section: 13.2

SRD Section	SRD Title	Requirements	Source Document
3.6.3.1.4	Fault Isolation	a) The NIMS shall access the fault isolation data capabilities of the NEXCOM (Sub)system(s).	RD Section: 5.1.2; 5.1.3
3.6.3.1.5	Service/Equipment Certification	a) The NIMS shall provide access to those functions that are provided by the NEXCOM System for Service/Equipment Certification.	RD Section: 5.1.2; 5.1.3
3.6.3.1.6	Digital Link Integrity	a) The NIMS shall provide monitoring status of the Digital Link Integrity provided by the NEXCOM System.	RD Section: 5.1.2; 5.1.3
3.6.3.1.7	UHF Interface	a) The NEXCOM System shall collect, transport, and provide to the NIMS interface the MMC functionality of the UHF radios collocated with NEXCOM MDRs in accordance with the NEXCOM/NIMS ICD UHF radio subsections.	RD Section: 5.1.2; 5.1.3
3.6.3.2	NIMS Security	a) The NIMS shall support the assignment of a unique logon identifier for each user.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	b) The NIMS shall authenticate the claimed user's identity before allowing the user to perform any actions other than a well-defined set of operations.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	c) When passwords are to be used for authentication, the NIMS shall use strong passwords (e.g., prevent the use of dictionary words).	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	d) The NIMS shall enforce mandatory password changes at set intervals.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	e) The NIMS shall prevent the reuse of passwords on a per user basis.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	f) The NIMS shall implement strong authentication.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	g) The NIMS shall enable access Authorization Management.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	h) The NIMS shall temporarily (a configurable period of time) suspend user accounts after a configurable number of consecutive failed logon attempts.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	i) The NIMS shall protect NEXCOM information system security data and functionality from all unauthorized access.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	j) The NIMS shall terminate NEXCOM control access to any subsystem after a configurable amount of NEXCOM control access inactivity.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1
3.6.3.2	NIMS Security	k) The NIMS System shall assure the integrity of all NIMS information being sent to NEXCOM.	RD Section: 7.3.3.1; 7.3.2.1; 7.3.1.1; 7.3.4.1

SRD Section	SRD Title	Requirements	Source Document
3.6.4.2.1	Next Channel Uplink Information	a) The automation system shall have the capability to provide the next radio channel setting information to the NEXCOM System.	RD Section: 3.1.9.1; Attachment 2 par. 3
3.6.4.2.1	Next Channel Uplink Information	b) Next Channel Uplink information shall be recorded.	RD Section: 3.1.9.1; Attachment 2 par. 3
3.6.4.2.2	Urgent Downlink Request	a) The automation system shall receive urgent downlink requests from the NEXCOM System and display to the controller.	RD Section: 3.1.1.4; 3.1.9.1; Attachment 2 par. 8
3.6.4.2.3	Mobile User Logged In Feature	a) The automation system shall provide the capability of displaying to the operator all logged in members of a Talk Group based on input from the NEXCOM System.	SRD Section: 3.2.2.1; RTCA DO-224A
3.6.4.2.4	Talker ID Feature	a) The automation system shall indicate to the controllers display which Mobile User is talking on the voice channel based on input from the NEXCOM System.	SRD Section: 3.2.2.1; RTCA DO-224A
3.6.4.2.5	Data Interface	a) The CPDLC automation system shall interface the NEXCOM A/G Router to the ATN network.	SRD Section: 3.2.3.2.1.1; 3.3.3.2.1.1; 3.3.3.2.1.2; 3.4.3.1.4; 3.4.4.1; Appendix B
3.6.4.3	Security Management	a) Automation shall implement a Public Key Infrastructure (PKI).	RD Section: 7.3.4.1
3.6.4.3	Security Management	b) Automation's PKI shall support and maintain the key management of NEXCOM Subsystems.	RD Section: 7.3.4.1
3.7.1.2.1	PTT/PTT Release Confirmation	a) The response time for the VSCE indication to the controller of PTT/PTT Release Confirmation, from the instant the GNI provides/removes the PTT/PTT Release Confirmation signal at the VSCE/GNI interface, shall not exceed 200ms for 99.9% of the events.	SRD Section: 3.6.1.2.4
3.7.1.2.2	Preemption of Mobile Users' Voice Transmissions	a) The VSCE shall deliver the Voice Preemption signal within 50 ms of activation by a user for 99.9% of the events.	SRD Section: 3.6.1.2.1
3.7.1.2.3	Preemption Confirmation of Mobile Users' Voice Transmissions	a) The response time for the VSCE indication to the controller of Voice Preemption Confirmation from the instant the GNI provides/removes the Voice Preemption Confirmation signal at the VSCE/GNI interface, shall not exceed 200ms for 99.9% of the events.	SRD Section: 3.6.1.2.1
3.7.1.2.4	Squelch Break	a) The response time for the VSCE indication to the controller of Squelch Break, from the instant the GNI provides/removes the Squelch Break signal at the VSCE/GNI interface, shall not exceed 150ms for 99.9% of the events.	SRD Section: 3.6.1.2.4

SRD Section	SRD Title	Requirements	Source Document
3.7.1.2.5	Ground Radio Resource Selection Confirmation	a) The response time for the VSCE indication to the controller of Ground Radio Resource Selection Confirmation, from the instant the GNI provides/removes the Radio Resource Selection Confirmation signal (e.g., Main/Standby transmitter/receiver confirmation, and BUEC select/reset confirmation) at the VSCE/GNI interface, shall not exceed 150ms for 99.9% of the events.	SRD Section: 3.6.1.2.2
3.7.1.2.6	Channel Busy Signal	a) The response time for the VSCE indication to the controller of Channel Busy, from the instant the GNI provides/removes the Channel Busy signal at the VSCE/GNI interface, shall not exceed 150ms for 99.9% of the events.	SRD Section: 3.6.1.2.3
3.7.2.1.1	Telecommunications Latency	a) One-way transfer delay contribution from terrestrial telecommunications alone shall not exceed 25 ms.	RD Section: 3.2.7.1
3.7.2.1.2	Line Characteristics	a) Analog telecommunications shall meet the performance requirements as specified in Telcordia TR-NWT-000335, based on FAA Order 6000.22A.	SRD Section: 3.2.3.8.1; RD Section: 4.10; Telcordia TR-NWT-000335
3.7.2.1.2	Line Characteristics	b) Digital telecommunications shall meet the performance requirements as specified in Telcordia GR-499-CORE, based on FAA Order 6000.47.	SRD Section: 3.2.3.8.1; RD Section: 4.10; Telcordia GR-499-CORE; FAA Order 6000.47
3.7.2.1.2	Line Characteristics	c) Digital telecommunications connectivity shall provide a minimum of 99.9% error-free seconds for any 24-hour period.	RD Section 4.10
3.7.2.4	Telecommunications Availability	a) Telecommunications paths shall provide an availability of at least 0.9979.	RD Section: 4.10; SRD App E
3.7.3	NIMS Performance Requirements	a) The NIMS shall support NEXCOM System MMC performance characteristics in accordance with FAA-E-2911, Section 3.2.3 a).	RD Section: 5.1.2; 13.2; FAA-E-2911 Section: 3.2.3 a
3.7.3	NIMS Performance Requirements	b) The NIMS shall not interfere with the operational performance of the NEXCOM System.	RD Section: 5.1.2; 13.2; FAA-E-2911 Section: 3.2.3 a
3.7.3	NIMS Performance Requirements	c) The NIMS shall accommodate low data (high latency) rates.	RD Section: 5.1.2; 13.2; FAA-E-2911 Section: 3.2.3 a

APPENDIX E

NEXCOM Reliability, Maintainability, and Availability (RMA) Analysis

E.1.0 Introduction

This appendix provides the reliability/maintainability/availability (RMA) analysis for the NEXCOM System Voice and Data services in the en route and Terminal domains. The purpose of this appendix is to determine the redundancy and MTBF requirements for the NEXCOM GNI and RIU and to ensure that:

a) the RCAG mean time between outages (MTBO) is greater than or equal to 19,996 hours as specified in the NEXCOM Segment 1 RD Section 3.2.2.2 in accordance with NAS-SS-1000, Volume I, par. 3.2.2.1.
b) the voice service availability (as defined by FAA Order 6040.15, par. 702c) is 0.99999 or greater as specified in the NEXCOM SRD, Section 3.3.7.3.1, and the NEXCOM RD, Section 3.2.4.1, in accordance with NAS-SS-1000, par. 3.2.1.2.8.2a.
c) the data service availability (as defined by FAA Order 6040.15C, par. 702c) is 0.99999 or greater as specified in the NEXCOM SRD, Section 3.3.7.3.2, in accordance with NAS-SR-1000, Section 3.2.1c.
d) the NEXCOM system equipment has an inherent availability of 0.999975 or greater as specified in the NEXCOM SRD, Section 3.3.7.3.3, and the NEXCOM RD, Section 3.2.4.2, in accordance with NAS-SS-1000, Volume I, par. 3.2.4.

The high-level findings are the following:

a) The RCAG MTBO and inherent availability requirements can be met with an RIU MTBF of 27,000 hrs. This is the minimum MTBF requirement for the RIU in order that the RCAG meet the RD MTBO requirement mentioned earlier. However, to add some “safety” margin, and to reduce the number of maintenance actions, an MTBF of 40,000 hrs is recommended.
b) In all cases where a redundant GNI is assumed, a GNI MTBF of approximately 10,000 hrs per thread is sufficient to meet the service availability requirements. However, a higher MTBF is recommended for the same reasons given for the RIU. It is not possible to meet the service availability requirements without GNI redundancy for any reasonable GNI MTBF values.
c) In order to meet the En Route Voice and Data Service Availability requirement of 0.99999, GNI redundancy and BUEC are required; however, neither RIU redundancy nor telecommunications link redundancy (i.e., ARTCC-to-RCAG telecommunications link) are required.
d) For en route Data Service, in addition to the requirements of the previous bullet, redundancy is required for both A/G Router and LAN in order that en route Data Service has an availability of 0.99999.
e) In order to meet the Terminal Voice Service availability requirement of 0.99999 in the split main/standby (M/S) configuration, GNI redundancy is required and an RIU is required at both the main and standby sites. Redundancy of the RIU is not required.
f) It is difficult to meet the Terminal Voice Service availability requirement of 0.99999 using the two-sited split transmitter/receiver (STR) configuration, even if the GNI and RIU are

made redundant. Increasing the GNI MTBF from 10,000 hrs to 100,000 hrs and assuming GNI redundancy is still not sufficient to obtain a Terminal Voice Service availability better than 0.99998 for the two-sited STR configuration.

g) Assuming a split M/S configuration in the Terminal environment, if a high-availability WAN is available to connect the ATCT/TRACON to the ARTCC, then the A/G Router and the LANs in both control facilities must all be made redundant in order to achieve a Terminal Data Service availability of 0.99999. If the WAN has a low availability, then it is not possible for Terminal Data Service to have an availability of 0.99999 even with redundancies provided in the various components.

The NEXCOM Segment 1 RD refers to NAS-SS-1000 and FAA Order 6040.15C for reliability, maintainability, and availability definitions. The next section discusses these definitions and points out some discrepancies.

E.1.1 RMA Definitions, Model Assumptions, and Modeling Approach

E.1.1.1 RMA Definitions

FAA Order 6040.15C and NAS-SS-1000 were both referenced in the NEXCOM RD as sources of RMA information. The NAS-SS-1000 provides its own RMA definitions. The RD references NAS-SS-1000 for RMA requirements yet references FAA Order 6040.15C for RMA definitions, which differ from the RMA definitions provided in NAS-SS-1000. This section points out the discrepancies and provides the rationale for the decisions regarding the selection of RMA definitions used for the analysis in this appendix.

The following definitions, not referenced in the RD, are provided in NAS-SS-1000, Volume I, Chapter 6 – Terms and Definitions:

Operational Availability: A measure of availability that includes the combined effect of item designs, application, operation, maintenance, and repair (including logistics travel time etc.). (This was used in the allocation of subsystem availability from the service availability goals in NAS-SR-1000).

Service/achieved availability: A measure of availability obtained as a result of measured field operating data (i.e., for identifying projected requirements, the service/achieved availability can be considered synonymous with operational availability).

Mean Time to Repair (MTTR): A basic measure of maintainability: the sum of corrective maintenance times, divided by the total number of failures within an item. Corrective maintenance is all actions performed as a result of failure in an end item. Corrective maintenance can include any or all of the following steps: localization, isolation, disassembly, interchange, reassembly, alignment, and checkout.

The discrepancies are the following:

a) NAS-SS-1000 equates operational availability and service/achieved availability. However, the RD references FAA Order 6040.15C, par. 702 c, for the voice service availability definition. Par. 702 c is a definition for equipment and service availability. FAA Order

6040.15C, par 702 b, provides a definition for operational availability which differs from equipment and service availability. Operational availability as per FAA Order 6040.15C takes into account both scheduled and unscheduled outages, whereas equipment and service availability takes into account unscheduled outages only.

b) NAS-SS-1000 and FAA Order 6040.15C give different definitions for MTTR. In NAS-SS-1000, MTTR *is mean time to repair* and **does not** include logistical time, travel time, or administrative time, etc. In FAA Order 6040.15C, MTTR is *mean time to restore* and **does** include logistical time, travel time, and administrative time, etc. For the RCAG MTBO requirement, the RD references FAA Order 6040.15C, par. 702f for MTTR used to compute MTBO, and specifies 0.5 hours for it. Since MTTR in FAA Order 6040.15C, par. 702f, includes logistical time, travel time, administrative time, etc., it does not make sense for it to be as small as 0.5 hours.
c) Mean Down Time, instead of MTTR from NAS-SS-1000, corresponds to Mean Time To Restore from FAA Order 6040.15C.

Because of the discrepancies, an attempt was made to determine what was intended for the definitions of service availability and MTTR. The following bullets present the decisions made regarding the RMA definitions used for the analysis in this appendix.

a) Service availability is computed using the NAS-SS-1000 definitions of MTTR and Mean Down Time. MTTR is used for all NEXCOM unique equipment, and Mean Down Time for all non-NEXCOM unique components (e.g., voice switches, telecommunications links, local- and wide-area networks, etc.). Mean Down Time includes all repair, logistical, travel, and administrative times. The set of assumptions in the next section provides a list of NEXCOM unique equipment.
b) MTBO for the RCAG, as described in NEXCOM Segment 1 RD, section 3.2.2.2, in accordance with NAS-SS-1000, Volume I, par. 3.2.2.1, is determined using an MTTR of 0.5 hours, in accordance with NEXCOM Segment 1 RD, Section 3.2.3.1. The 0.5 hours is applied to each piece of equipment at the RCAG, rather than to the entire RCAG.
c) In order that the RCAG MTBO be at least 19,996 hours, the inherent availability for NEXCOM system equipment must be greater than 19,996 hours. The NEXCOM Segment 1 RD, Section 3.2.4.2, requires NEXCOM system equipment to have an inherent availability of 0.999975 or greater. Using a 0.5 MTTR for NEXCOM system equipment, the inherent availability of 0.999975 translates into an MTBF of 19,996 hours. Thus, if each piece of equipment at the RCAG has an inherent availability of 0.999975, the RCAG MTBO would fall below 19,996 hours. The inherent availability requirement of 0.999975 is thus applied to the RCAG, rather than to each piece of equipment at the RCAG. In this way, the RCAG will meet the MTBO requirement of 19,996 hours.

E.1.1.2 Model Assumptions

The following modeling assumptions were made in the RMA computations:

a) Data and voice are not considered as backups for each other.
b) Voice switches are included for NEXCOM en route and Terminal A/G Voice System availability computations.
c) Controller-Pilot Data Link Communications (CPDLC) unique equipment, except for the A/G Router and the LANs in the ARTCC and ATCT/TRACON, is not included in the Data System availability computations.

d) The time to access a backup or standby system is not included.
e) Complete diversity between primary and backup paths is assumed.
f) Service availability is computed independently for voice and data services on a per User Group basis
g) The switchover from prime power to standby power is assumed perfect, i.e., the transfer switch is assumed to have an availability of 1 and the sensing and switchover time is assumed to be negligible.
h) In the Terminal environment, the same commercial power supply is assumed for all the different sites of the RTR (i.e., sites in the split M/S or STR configurations). Each separate site of the RTR is assumed to have separate battery backups.
i) In the Terminal environment, results are presented with and without the assumption of a voice switch bypass (VSBP) for the Terminal voice switch (TVS). Both sets of results are presented to account for the different levels of ATCT/TRACONs. Most level 3 and above ATCT/TRACONs have VSBP, but most lower level ATCT/TRACONs do not.
j) Non-NEXCOM unique equipment at the radio site includes the antennas, commercial power, and standby power. The non-NEXCOM unique equipment at the control facility includes the voice switches (primary and backup). At a radio site, to compute the availability of non-NEXCOM unique equipment, with the exception of commercial power as noted in k), a 20 hr "restoral time" is used. To compute the availability of non-NEXCOM unique equipment at a control facility, a 2 hr "restoral time" is used. NEXCOM unique equipment includes: RIU, MDR transmitters, MDR receivers, timing source, timing reference, GNI. To compute the availability of NEXCOM unique equipment, the specified MTTR of 0.5 hrs is used.
k) To compute the availability of commercial power at a radio site an 8 hr. "restoral time" is used.
l) MMCWS is part of the NEXCOM System, but is not modeled because it is part of the MMC system, the failure of which does not affect the operation of voice and data.
m) A "parallel" model is assumed for main and standby radios in the En Route environment.
n) A "parallel" model is assumed for primary and backup strings in the En Route environment.
o) A "parallel" model is assumed for main and standby strings of the split M/S configuration, and for transmitter and receiver strings of the STR configuration in the Terminal environment.
p) In the En Route environment, all combinations of main and standby transmitters and receivers are possible. For example, main transmitter/main receiver, main transmitter/standby receiver, standby transmitter/main receiver, etc.
q) The FTI RMA4 values for the NEXCOM telecommunications link are used. The telecommunications RMA4 availability value of 0.9979452 has been rounded to 0.9979 for this analysis. With this availability value, the FTI RMA4 Mean Down Time of 3 hrs is used to compute the MTBF.
r) Although there are several different ways used to configure RTR sites, two are considered in this appendix – the split M/S configuration using two sites, and the split transmitter/receiver (STR) configuration using two sites. There are four-site configurations used today, however, these are not analyzed. The two-site configurations provide a lower bound on the service availability that can be achieved, and are therefore sufficient to determine if the service availability requirements can be met for most of the other configurations.
s) For the two communications paths to the two RTR sites (either split M/S or STR configurations) in the Terminal environment, one communications path is assumed to be

provisioned on airport cable and the other on low-density radio communications link (LDRCL). The LDRCL is assumed to be comprised of two LDRCL Terminals (LDRCLTs) and one LDRCL repeater (LDRCLR). This LDRCL configuration is referred to as 2 LDRCLT + 1 LDRCLR

t) Both cases of non-redundant and redundant telecommunications links to the RCAG are considered.
u) Redundancy of communications lines to Terminal radio sites is not considered.
v) A failure of the Timing Reference does not lead to a failure of NEXCOM for at least 30 days, therefore, the Timing Reference is assumed to have an availability of 1.

E.1.1.3 Modeling Approach

The modeling approach is based on Method 1001, Conventional Probability, of MIL-STD-756B. This method requires developing a reliability block diagram (RBD) for each configuration considered and then determining the availability of the configuration using standard probability arguments. The same RBD and manipulations of the RBD for finding availability can be used to find MTBO.

E.2.0 DERIVATION OF RELEVANT MTBFS/AVAILABILITIES

Table E-1 shows the data used in all of the analyses in this appendix. The RIU and GNI MTBF values have been parameterized. The other MTBF values are predicted values, generic values, or values estimated from field data (FAA outage data or FAA personnel expertise). The analyses in this appendix will determine the MTBFs for the RIU and GNI. In addition, the analyses will also determine the RIU's and GNI's redundancy requirements.

Table E-1

MTBF (hrs)/Availability Data Used for Analysis

ITEM	MTBF (hrs)/ Availabilities	Predicted Data	FAA Outage Data	Field Data not Available from FAA Outage Data
Single Transceiver (6)	*26,280*	√		
Timing Source (16))	150,000	√		
Prime Power (2)	4,586-6,738			√
Backup Power (11)	43,800-61,320			√
Prime + Standby Power + Transfer Switch(5)	162,622		√	
RIU	*parameter*			
GNI	*parameter*			
A/G Router (9)	*parameter*			
Timing Reference (3)	1	√		
VHF Antenna (8)	43,800-61,320			√
Leased Line (4)	0.9979	√		
VSCS (12)	0.99999		√	

VTABS (13)	0.99986		√	
Terminal Voice Switch (15)	0.99749 to 0.99996		√	
VSBP (7)	0.99986		√	
LAN (1)	50,000	√		
LDRCL = 2 LDRCLT + 1				
LDRCLR (10)	0.998264		√	
WAN RMA1 (14)	0.9999971	√		
WAN RMA4 (14)	0.9979	√		

Notes:

1. *Generic value from Reliability Handbook [1]*
2. *ANM-473 indicates that commercial power outages occur several times per year at a radio site. State of Connecticut Dept. of Public Utility Control [ref…] shows that the average over a 6 year period (1992 – 1997) was 1.3 (no major storms) – 1.9 (major storms) commercial power outages per customer per year. This corroborates ANM-473's data that commercial power MTBO per customer is less than a year. As a conservative estimate, the State of Connecticut data is used for this analysis.*
3. *Failure of Timing Reference does not degrade system performance for at least 30 days. For RMA analysis it is equated to an availability of 1.*
4. *As specified in the SRD, rounded from the value of 0.9979452 specified for RMA4 service in the FAA Telecommunications Infrastructure (FTI) Screening Information Request (SIR), DTFA01-00-S-00FTI, Attachment J.1 (FAA Telecommunications Services Description).*
5. *Obtained from National Airspace System Performance Analysis System (NASPAS) data FY1998 [2]*
6. *SRD requirement – specified as 26,280 hrs for a transmitter/receiver combination (i.e., transmitter and receiver considered in series for reliability/availability purposes – meaning a failure in either one causes a radio failure*
7. *VSBP not NASPAS reportable. VTABS availability number is used for VSBP.*
8. *ANM-473 indicates that antennas last 5-7 years.*
9. *The MTBF range of 19,996 hrs to 100,000 hrs produced no significant differences in the results to be presented.*
10. *Obtained from NASPAS data 6/97 – 5/98 [2]. The corresponding MTTR for 2 LDRCLT + 1 LDRCLR using NASPAS data is 63.7 hrs.*
11. *ANM-473 indicates that batteries last 5-7 years. 5 years will be used for this analysis.*
12. *NASPAS data for FY1998 and FY2000.*
13. *NASPAS data for FY2000.*
14. *FAA Telecommunications Infrastructure (FTI) Screening Information Request (SIR), DTFA01-00-S-00FTI, Attachment J.1 (FAA Telecommunications Services Description). As indicated in note 4, an availability value of 0.9979 rather than 0.9979452, is used for RMA4.*
15. *NASPAS data for FY2000 (see Section E.4 for detailed information).*
16. *TNT Rubidium clocks have a predicted MTBF of 600,000 hours. Other manufacturers predict 20-22 years (approximately 175,000 to 190,000 hours). To be conservative, an MTBF of 150,000 hours is assumed for the time source.*

E.3.0 NEXCOM VOICE SYSTEM

In this section the NEXCOM Voice Systems for en route and terminal environments are analyzed with respect to their RMA requirements.

E.3.1 NEXCOM Voice System for En Route Environment

The NEXCOM voice system for the En Route environment is comprised of a "primary" string and a "backup" string. Figure E-1 provides a high-level depiction of En Route A/G communications strings.

The backup string provides backup for the primary string and would be accessed by the controller in the event of a primary string failure.

The RCAG facility contains main and standby radios and other equipment (power, Timing Source, etc.) at the radio site and is connected by means of leased telecommunications links, in most cases, to the ARTCC.

The backup emergency communications (BUEC) facility is also connected to the ARTCC by means of leased telecommunications links, in most cases, and contains main radios (i.e., no standby), and other equipment.

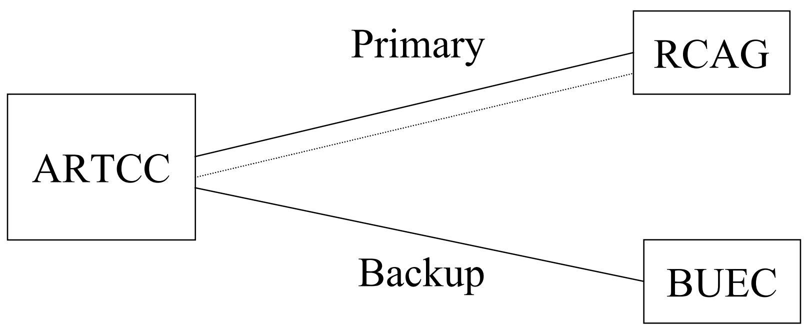


Figure E-1

High-Level En Route A/G Communications Strings

RCAG and BUEC facilities generally serve more than one controller. The RD requires that the RCAG MTBO be equal to or greater than 19,996 hours.

In this appendix, RCAG consists of the equipment at the primary remote radio site required to provide services to a single User Group. The following list and Figure E-2 (a) show the RCAG equipment required for a single User Group:
a) RIU
b) main transmitter
c) standby transmitter
d) main receiver
e) standby receiver
f) two VHF antennas
g) prime power (i.e., commercial power)

h) secondary power (i.e., battery backup)
i) power transfer switch
j) Timing Source
k) Timing Reference

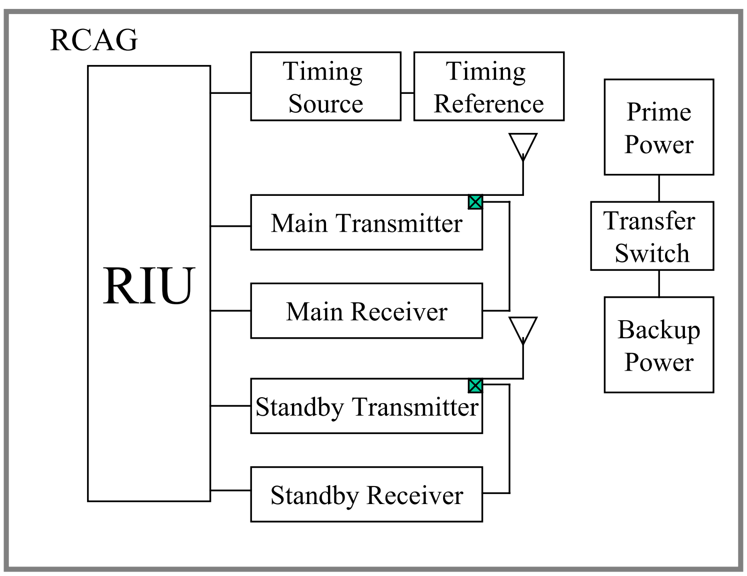
In addition, for the purpose of computing the RCAG MTBO, an RCAG outage is defined with respect to a single User Group and is defined as follows.

An RCAG outage is defined as a failure of the RCAG resulting in the inability of the controller to transmit or receive.

For example, if the main transmitter failed, but the controller can still transmit over the standby transmitter, then the main transmitter failure alone would not result in an RCAG outage.

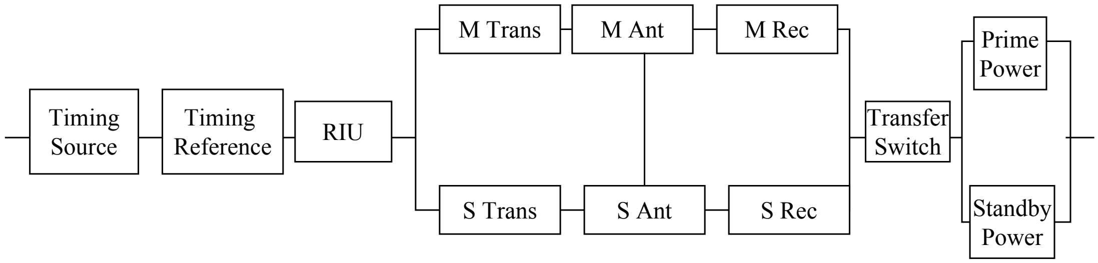
As another example, if the controller can transmit, but cannot receive from either main or standby receivers, then this would result in an RCAG outage.

Figure E-2 (b) shows the reliability block diagram (RBD) used to derive the RCAG MTBO and also used for the calculation of A/G voice service availability.



(a) Physical Configuration

Comment: The Timing Source is connected to a Timing Reference in our NEXCOM Model. The Timing Source is part of the NEXCOM system, the Timing Reference is not part of the NEXCOM system, although it is unique to NEXCOM.



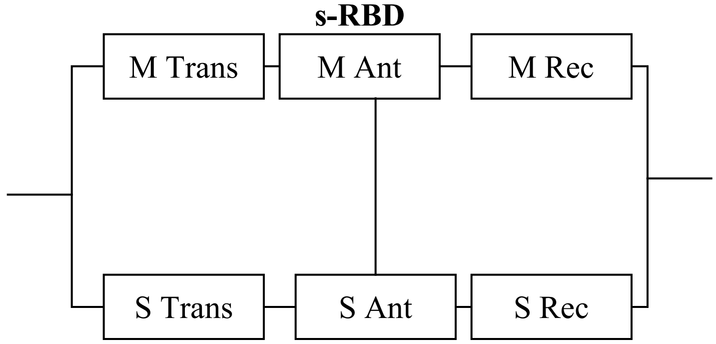
(b) Reliability Block Diagram

Figure E-2

RCAG RMA Analysis

To avoid confusion, an explanation of the RCAG transmitter/receiver/antenna subsystem RBD (s-RBD) is in order as the connectivity lines are not physical connections. That portion of Figure E-2 is reproduced here.

s-RBD



This s-RBD allows for any combination of transmitter with receiver as stated in the assumptions previously. For example, it allows: the main transmitter to be used with the standby receiver in the event of a main receiver failure; the standby transmitter to be used with the main receiver in the event of a main transmitter failure, etc.

This s-RBD is a complex series-parallel combination as defined in MIL-STD-756B. However, this s-RBD will have a "simple" series and/or parallel configuration in certain states of a subset of its components. There are only two possible states for each component – a success state and a failure state. If a component is in a success state, it is assumed to have an availability of 1; otherwise, it is assumed to have an availability of 0. If a component is in a success state, it is short circuited in the s-RBD. If a component is in a failure state, it is open circuited in the RBD.

All possible success and failure states of the chosen components must be considered. The components are chosen so that the s-RBD with the chosen components in any combination of success or failure states has a simple series and/or parallel configuration. This is done because it is a straightforward procedure to find availabilities (and MTBOs) for series and parallel configurations. Once the availabilities of the s-RBD in all possible states of the chosen components are found, these availabilities are multiplied by the corresponding state probabilities. These products are summed to find the availability of the s-RBD. This procedure is described and applied to an example in MIL-STD-756B, Section 2.1.3.1, pg. 1001-5, D-2. The components chosen for the above s-RBD are the two antennas.

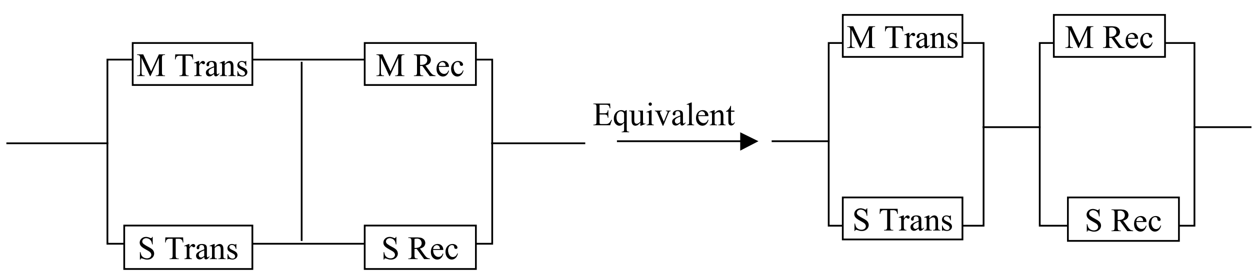
The above process is now applied to the above s-RBD. By going through this process, it becomes apparent how the s-RBD can accommodate the different transmitter/receiver combinations. As mentioned above, these states are also used to facilitate the computation of the RCAG availability. There are four possible states of the two antennas:

Both antennas are operational
The main antenna has failed, but the standby antenna is operational
The standby antenna has failed, but the main antenna is operational
Both antennas have failed

State 1. Both antennas are operational:

The probability of being in this state is $A_{Ant\_M} A_{Ant\_S}$

In this state, the s-RBD can be redrawn as the figure below on the left to represent the case where the antennas have availability of 1. However, the left figure is equivalent to the right figure which is a parallel combination of transmitters in series with a parallel combination of receivers. The implication of this configuration is that any combination of transmitter and receiver can be used as long as both antennas are operational. It also implies that a loss of either transmit or receive functionality implies a loss of service from the RCAG. The availability and MTBO of this configuration are easy to compute since this configuration is a parallel combination in series with another parallel combination.

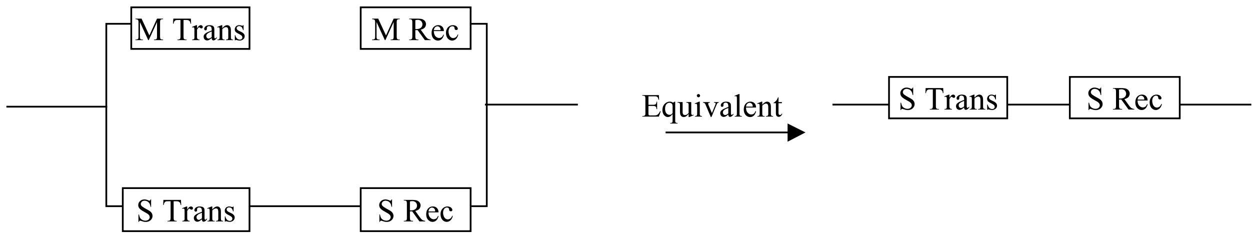


$$A_{State\,1} = (A_{M\ Tr} + A_{S\ Tr} - A_{M\ Tr}A_{S\ Tr})(A_{M\ \mathrm{Re}\,c} + A_{S\ \mathrm{Re}\,c} - A_{M\ \mathrm{Re}\,c}A_{S\ \mathrm{Re}\,c})$$

State 2. The main antenna has failed, but the standby antenna is operational.

The probability of being in this state is $(1 - A_{M\ Ant})A_{S\ Ant}$

In this state, the only operational communications path is through the standby transmitter and receiver as the equivalence of the configurations show. Also, whenever, the standby transmitter or receiver fails, there is a loss of service from the RCAG. Since the equivalent configuration is two single elements in series, the computation of availability (MTBO) is just the product (inverse of the sum) of the availabilities (failure rates) of the standby transmitter and standby receiver.

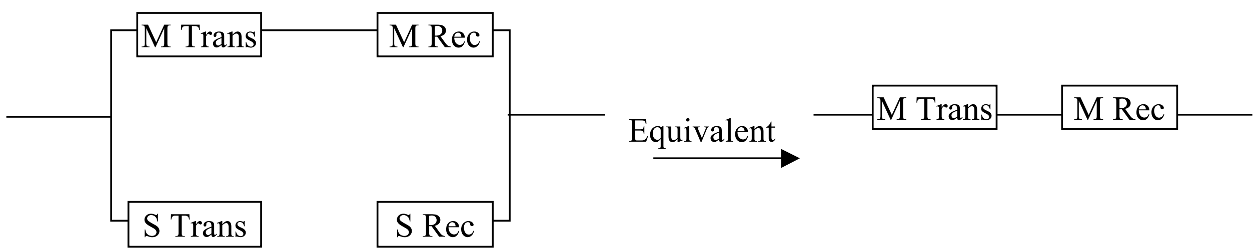


$A_{State\,2} = A_{S\;Tr} A_{S\;\mathrm{Re}c}$

State 3. The standby antenna has failed, but the main antenna is operational:

The probability of being in this state is $(1 - A_{S\;Ant})A_{M\;Ant}$

In this state, the only operational communications path is through the main transmitter and receiver as the equivalence of the configurations show. Also, whenever, the main transmitter or receiver fails, there is a loss of service from the RCAG. This state is similar to the previous state and the computations of MTBO and availability are similar.



$A_{State\,3} = A_{M\;Tr} A_{M\;\mathrm{Re}c}$

State 4. Both antennas have failed.

The probability of being in this state is $(1 - A_{S\;Ant})(1 - A_{M\;Ant})$

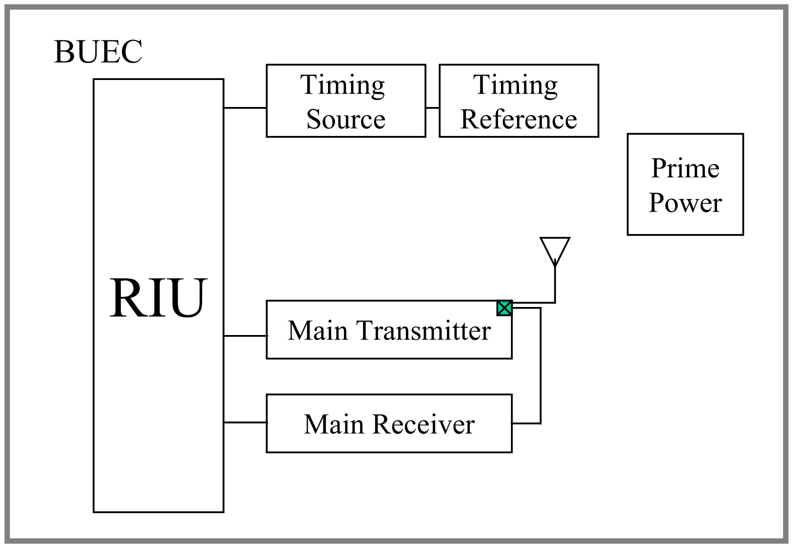
In this state there is no service from the RCAG, i.e., communications through the RCAG is not possible.
$A_{State\,4} = 0$

The availability of the transmitter/receiver/antenna s-RBD is then found as:

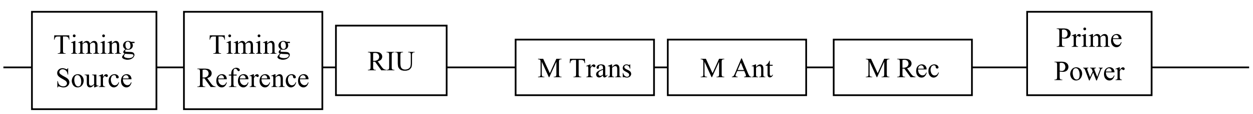
$$A_{s-RBD} = A_{M\;Ant} A_{S\;Ant} A_{State\,1} + (1 - A_{M\;Ant}) A_{S\;Ant} A_{State\,2} + (1 - A_{S\;Ant}) A_{M\;Ant} A_{State\,3}$$

Figure E-3 and the following list provide the equipment for the BUEC:
a) RIU
b) main transmitter
c) main receiver

d) VHF antenna
e) prime power
f) Timing Source
g) Timing Reference



(a) Physical Configuration



(b) Reliability Block Diagram

Figure E-3

BUEC RMA Analysis

Because there may be cases where an RCAG is not provided a BUEC backup, an RMA analysis of the primary connectivity alone is provided. The availability of the primary connectivity would then correspond to the voice service availability of the RD.

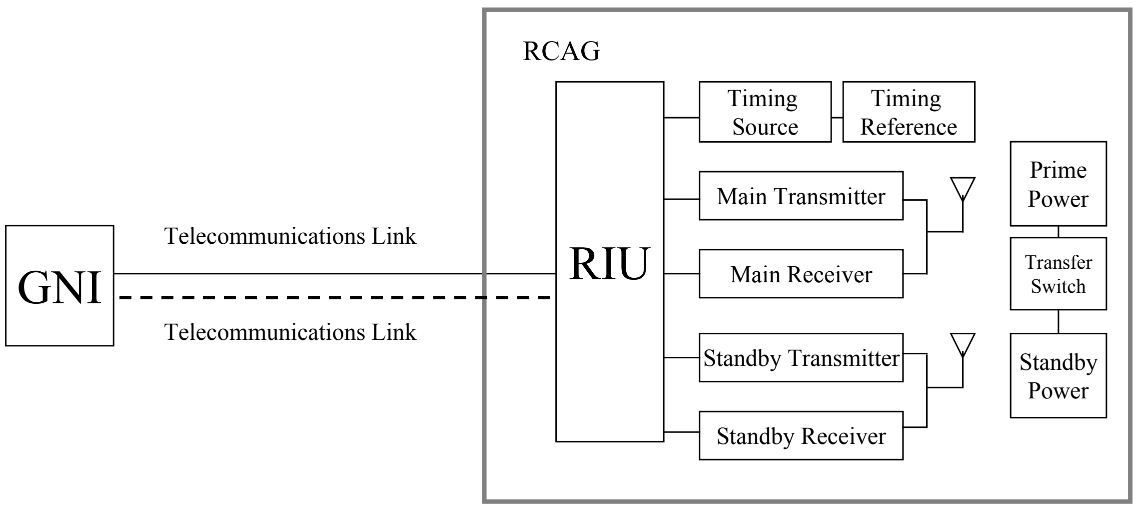
Figure E-4 shows the primary connectivity, which consists of the RCAG plus the telecommunications link connectivity to the ARTCC. The RMA analysis is performed with and without telecommunications link backup for connectivity between the ARTCC and its RCAG. In Figure E-4 a dashed line is used to indicate a backup telecommunications link.

The NEXCOM En Route A/G Voice System shown in Figure E-5 is the ground component that provides the NEXCOM En Route Voice Service. The NEXCOM En Route Voice System contains both the primary and backup (or BUEC) radio sites. The NEXCOM En Route Voice System availability would then correspond to the En Route Voice Service availability.

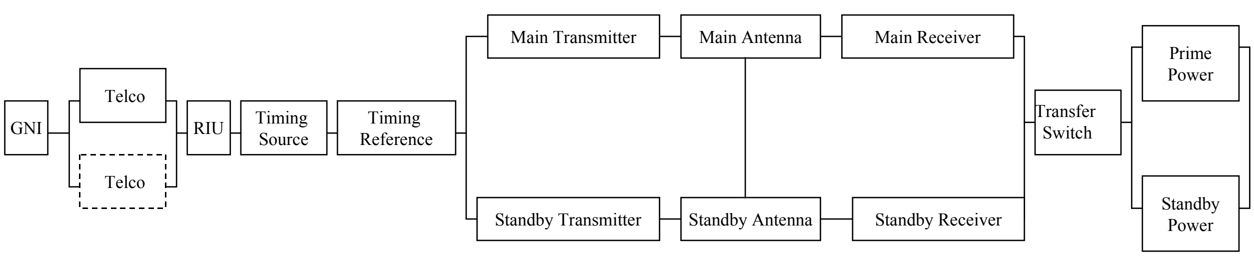
Figure E-5a shows the type of GNI redundancy considered in this appendix where one GNI serves the RCAG, and the other GNI serves the BUEC. In the event of a failure of the GNI which serves the RCAG, the controller must select the BUEC.

There are other ways in which GNI redundancy can be achieved. For example, each GNI could be used to access both the RCAG and the BUEC. In this case if the controller were using the RCAG, and the currently used GNI failed, an automatic switchover to the redundant GNI would allow the controller to continue using the RCAG.

In the GNI model used in this analysis, a GNI used to serve an RCAG cannot be used to serve the BUEC. Thus, the GNI-redundancy model used in this analysis is a worst-case model. This model is used in the En Route environment for both voice and data. In the Terminal environment a similar GNI-redundancy model is used and is described in a later section.



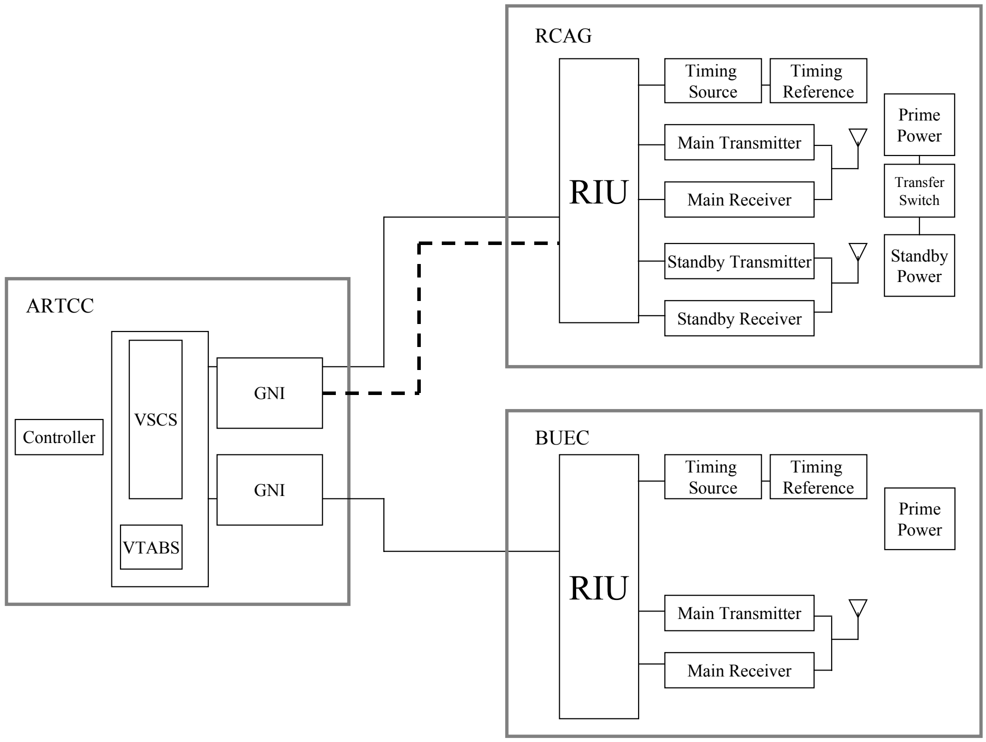
(a) Physical Configuration



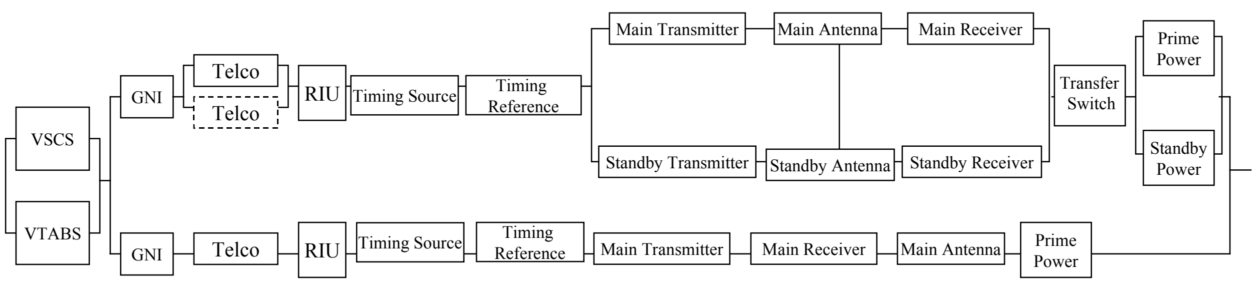
(b) Reliability Block Diagram

Figure E-4

Primary Path for NEXCOM En Route A/G Communications Subsystems



(b) Physical Configuration



(a) Reliability Block Diagram

Figure E-5

NEXCOM En Route A/G Voice System

E.3.1.1 NEXCOM RMA Requirements

Table E-2 summarizes the RMA requirements as specified in the NEXCOM RD. This appendix assumes that this overall service availability requirement applies to both the Terminal and En Route domains and for both voice and data A/G services, as both are assumed to be critical services.

Table E-2

RD Requirements

	MTBF (hrs)	MTBO (hrs)	MTTR* (hrs)	Availability
RCAG		≥ 19,996	≤ 0.5 (inherent)	
Transceiver	≥ 26,280			
Equipment				≥ 0.999975 (inherent)
Service Availability**				≥ 0.99999

* *According to NAS-SS-1000 definition and not FAA Order 6040.15C definition*

** *Voice or data (data service availability not specified in the RD, but is specified in NAS-SR-1000)*

E.3.1.2 NEXCOM En Route Voice Service RMA

E.3.1.2.1 NEXCOM RCAG MTBO and Inherent Availability Requirements

The RBD of Figure E-2 (b) is used to determine the MTBO of the RCAG. Once the RIU MTBF has been determined, this value will be used for the rest of the analyses to determine the GNI MTBF and the need for RIU and/or GNI redundancy so that the service availability requirements can be met.

Note that “MTBO” as used here should more appropriately be MTBF because 0.5 hrs, instead of an operational “restoral time”, is used for each component of the RCAG in computing the RCAG “MTBO” as required by the RD. Thus, the second column of Table E-3 is labeled “MTBF” instead of “MTBO.” Later references in this appendix for this particular RCAG requirement will continue to refer to it as the “RCAG MTBO” requirement to avoid confusion with the RD.

The following definitions are used for the RCAG MTBF and the NEXCOM RCAG inherent availability:

a) The RCAG MTBF is defined as the mean time between those failures of the elements in Figure E-2(a) that result in the inability of the controller to transmit or receive for a particular Talk Group.
b) The NEXCOM RCAG inherent availability is defined as the steady-state probability that the configuration of elements as shown in Figure E-2(a) results in the ability of the controller to transmit and receive for a particular Talk Group. The NEXCOM RCAG inherent availability is computed using the inherent availabilities of the items in Figure E-2(a), where the individual item inherent availabilities are computed using a 0.5 hrs MTTR and MTBFs as shown in Table E-1.

Table E-3 shows the RCAG MTBF results for the NEXCOM RCAG and shows that with an RIU MTBF of 26,889 hrs, the RCAG with a single RIU, will meet the MTBF requirement of 19,996 hrs and the inherent availability requirement of 0.999975.
For the remaining analysis in this appendix, an RIU MTBF of 40,000 hrs will be used as this value is sufficient to meet the requirements and provides some margin.

Table E-3

Determining RIU MTBF

RIU MTBF (hrs)	NEXCOM RCAG MTBF* (hrs)	NEXCOM RCAG Inherent Availability
26,280	19,658	0.9999745
26,889	19,996	0.9999750
30,000	21,667	0.9999769
40,000	26,442	0.9999811

* Corresponds to the RCAG MTBO requirement

***Note**: MTBF for transmitter and receiver in series = 26,280 hrs. For meeting NEXCOM RCAG requirements coasting is considered a mitigator of Timing Source failures (based on inherent MTTR of 0.5 hrs)*

E.3.1.2.2 En Route Primary Connectivity

There may be cases where it is not possible to provide BUEC coverage of a sector for a variety of reasons. This section was written mainly to cover this situation. Table E-4 shows the resultant MTBO of the primary connectivity (or the primary string), with varying GNI MTBFs. The primary connectivity includes the path from the GNI to the antennas at the radio site. Table E-4 considers two cases: a single telecommunications link connecting the ARTCC GNI and RCAG; and diverse and redundant telecommunications links connecting the ARTCC GNI and RCAG.

Table E-4 also shows the number of primary string failures per year that would result. This is also the number of times per year that the backup system (e.g., BUEC) would have to be accessed. As the GNI MTBF has not yet been determined, a range a values for the GNI MTBF is shown. It is apparent from Table E-4 that adding a redundant and diverse telecommunications link significantly increases the MTBO of the primary connectivity.

Tables E-5a and E-5b show the corresponding primary string availabilities, and also show the effect on the availability of providing a redundant RIU. Tables E-5a and E-5b show that there is not much of an improvement in availability by adding redundancy to the RIU.

Table E-5b shows that an order of magnitude improvement is obtained by adding a fully diverse redundant communications path between the GNI and the primary radio site. In addition, Table E-5b shows that an availability exceeding 0.9998 can be achieved for the primary connectivity when redundant and diverse telecommunications links are provided.

Table E-4

MTBO for Primary Connectivity of the A/G Communications Subsystems Single-Threaded Primary Connectivity

GNI MTBF (hrs)	MTBO (hrs) A/B*	Number Failures per Year for Entire Primary Connectivity A/B*	Number of Failures per Year Due to Leased Line Failures Only A/B*
10,000	1,191/7,102	7.4/1.2	6.1/0.026
27,000	1,288/12,845	6.8/0.68	6.1/0.026
30,000	1,294/13,487	6.8/0.65	6.1/0.026
40,000	1,308/15,195	6.7/0.58	6.1/0.026
100,000	1,334/19,680	6.6/0.45	6.1/0.026

* A = Single Telecommunications Link Connectivity
B = Redundant Telecommunications Link Connectivity

Note: *MTBF for transmitter and receiver in series assumed to be 26,280 hrs.*

Note: *RIU – 40,000 hrs MTBF*

Table E-5a

Availability for Primary Connectivity (GNI-to-RCAG) Non-Redundant Primary Connectivity

GNI MTBF (hrs)	With Single RIU*	With Redundant RIU
10,000	0.99780	0.99781
27,000	0.99783	0.99784
30,000	0.99783	0.97784
40,000	0.99784	0.99785
100,000	0.99784	0.99786

* RIU – 40,000 hrs MTBF

Table E-5b

Availability for Primary Connectivity (GNI-to-RCAG) Redundant Telecommunications Links

GNI MTBF (hrs)	With Single RIU*	With Redundant RIU
10,000	0.99989	0.99991
27,000	0.99993	0.99994
30,000	0.99993	0.99994
40,000	0.99993	0.99994
100,000	0.99994	0.99995

* RIU – 40,000 hrs MTBF

E.3.1.2.3 Corrective Maintenance for Average En Route Primary Site

There are currently approximately 3 circuits per En Route radio site. For the 2V2D configuration of VDL Mode 3, 2 pairs of M/S MDRs would be required to support 3 circuits. The results are presented for all equipment and also for NEXCOM unique equipment. The equipment at this average site would include:

a) 2 RIUs (NEXCOM Unique)
b) 2 transmitters (M+S), 2 receivers (M+S) per RIU = 8 radio units (NEXCOM Unique)
c) 2 VHF antennas per RIU = 4 VHF antennas
d) 1 Timing Reference per RIU = 2 Timing References (NEXCOM Unique) (Not part of the NEXCOM System)
e) 1 Timing Source per RIU = 2 Timing Sources (NEXCOM Unique)
f) 1 prime power unit per site
g) 1 standby power unit per site

Table E-6 shows the Mean Time Between (Corrective) Maintenance Actions (MTBMA) and the corresponding number of corrective maintenance actions that would be required per year for a NEXCOM En Route radio site supporting 3 circuits. The results in Table E-6 assume that maintenance personnel are sent to the radio site whenever any item fails regardless of whether there is a standby unit. For different Mean Down Times, the results are approximately the same.

Table E-6

Corrective Maintenance for NEXCOM En Route Radio Site Supporting 3 Circuits

MTBMA* (hrs)	Number Corrective Maintenance Actions per Year for all Equipment at RCAG	Number of Corrective Maintenance Actions per Year for NEXCOM-Unique Equipment Only
1,751	5.0	2.0

* Mean Time Between (Corrective) Maintenance Actions
__Note__: RIU – 40,000 hrs MTBF

E.3.1.2.4 Probability of Standby Unit Failure During Repair Time of Main Unit

Of interest is also the probability that the standby transmitter (receiver) will operate without failure during the repair time of the failed main transmitter (receiver). With a radio unit (transmitter or receiver) MTBF of 52,560 hrs (i.e., transmitter + receiver MTBF of 26,280 hrs), the probability that the standby transmitter (receiver) will operate without failure during the Mean Down Time of the main transmitter (receiver) ranges from 0.999924 for an optimistic 4 hour Mean Down Time to 0.999620 for a Mean Down Time of 20 hours (i.e., the probability of a Standby failure during the Mean Down Time of the same-type main radio units is 7.6×10^{-5} for a Mean Down Time of 4 hours and 3.8×10^{-4} for a Mean Down Time of 20 hours).

E.3.1.2.5 NEXCOM En Route System Availability

The last requirement addressed in this appendix for En Route voice is the requirement that NEXCOM En Route System availability (i.e., equivalent to the RD's voice service availability) equal or exceed 0.99999. As the GNI MTBF has yet to be determined, the service availability requirement is calculated for a range of GNI MTBF values.

Also, an important consideration with regard to the RIU is its redundancy requirements. The redundancy of the RIU has little effect on the overall service availability (i.e., when both primary and backup connections are taken into account) as can be seen by comparing the last two columns of Table E-7.

However, Table E-7 does show that adding redundancy and diversity to the communications path substantially increases the service availability.

Additionally, with an RIU failure, the controller can still access the backup radio site. This means that the RIU is not a common point of failure for En Route communications service. Thus, RIU redundancy is neither required to satisfy FAA Diversity Order 6000.36 nor the service availability requirement.

Table E-7 also shows that when primary and backup systems (i.e., BUEC) are available, the service availability requirement can be met with a GNI MTBF of 10,000 hrs.

In addition Table E-7 shows that when both primary and backup systems are available there is not much improvement in service availability by increasing the GNI MTBF from 10,000 hrs to 100,000 hrs by providing RIU redundancy at the primary radio site, or by providing redundant connectivity to the primary radio site. Although a GNI MTBF of 10,000 hours may suffice to satisfy the service availability requirements, consideration must be given to the number of maintenance actions that an MTBF of 10,000 hrs would engender. This is discussed in a later section of this appendix.

Table E-7

NEXCOM En Route A/G System Availability

	NEXCOM En Route System Availability*	
GNI MTBF (hrs)	**Single RIU** A/B*****	**Redundant RIU** A/B*****
10,000	0.99999036/0.99999953	0.99999044/0.99999959
27,000	0.99999057/0.99999968	0.99999065/0.99999973
30,000	0.99999058/0.99999969	0.99999066/0.99999974
40,000	0.99999061/0.99999970	0.99999069/0.99999976
100,000	0.99999066/0.99999974	0.99999074/0.99999979

*   RF link and avionics not included
**   RIU MTBF = 40,000 hours
*** A = Single-threaded connectivity to primary site
*** B = Redundant connectivity to primary site

E.4.0 NEXCOM TERMINAL A/G VOICE SYSTEM

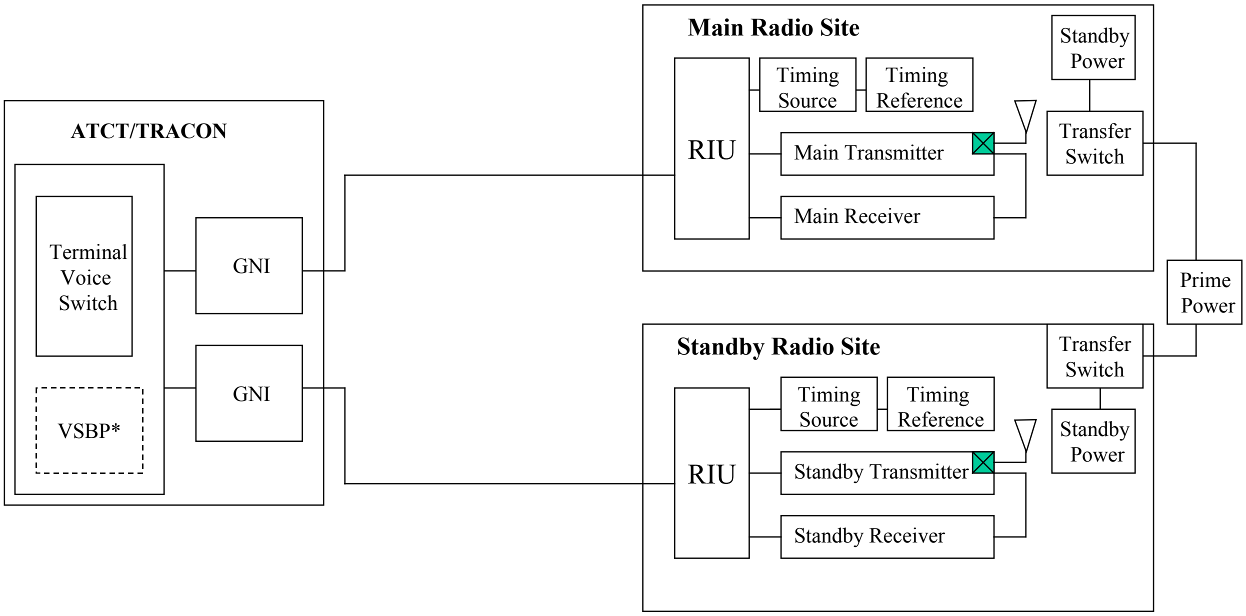
There are several radio site configurations used for the current Terminal A/G voice communications system. Two are considered in this appendix. Figure E-5 shows the split main/standby configuration where the main radios are at one location on the airport grounds and the standby radios are at another location. Figure E-6 shows the split transmitter/receiver (STR) configuration where main/standby transmitters are at one location on the airport grounds and main/standby receivers are at a different location. Only the two-sited configurations are considered in this appendix. There are three- and four-sited configurations as well. The two-sited results provide a lower bound on the service availability that can be achieved.

Figure E-7 also shows the STR configuration, but where there are two RIUs at both transmitter and receiver sites. There are two GNIs. In this configuration, one GNI is used to access the main transmitter and main receiver through two direct connections. The other GNI is used to access the standby transmitter and standby receiver through two direct connections. The model assumes that only main transmitter/main receiver and standby transmitter/standby receiver combinations are possible. This assumption results in lower bound service availability estimates.

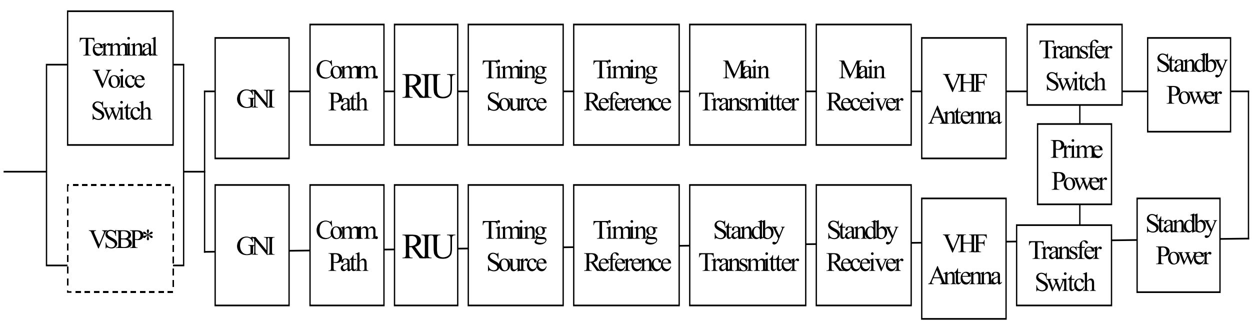
There are different types of voice switches used in the Terminal area. Table E-8 shows the different switch types used, the number of each type used in the field, their availabilities over the past 3 years [4].

Over the past year, all the Terminal switches had availabilities below 0.99999. However, many level 3 ATCT/TRACONs and above provide a VSBP for the voice switch. The analysis looks at two cases – VSBP is provided, and VSBP is not provided. This is done to cover all levels of ATCT/TRACONs.

As Table E-8 shows, the terminal A/G voice switch availabilities for FY2000 range from 0.99995 down to 0.99749. The analysis is done using just two values, the worst case of 0.99749 and a nominal value of 0.9999.



(a) Physical Configuration

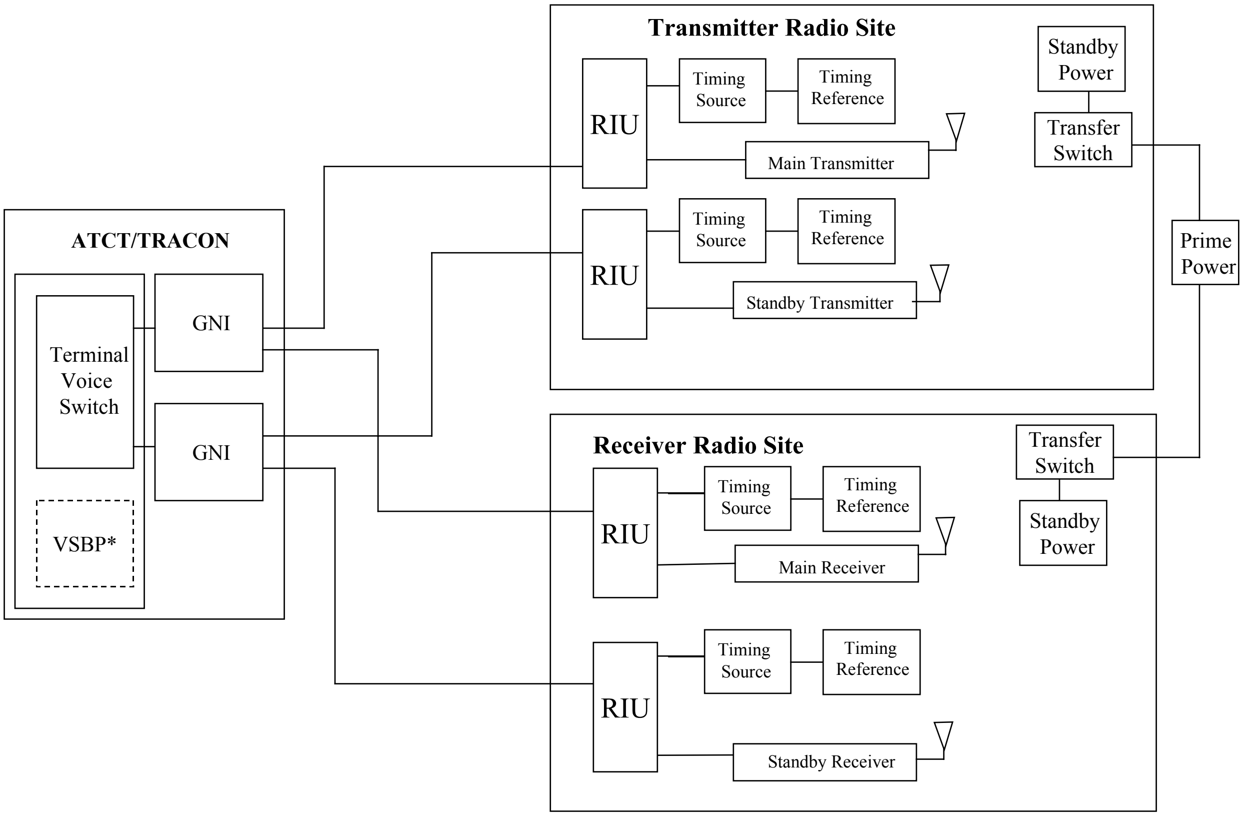


(b) Reliability Block Diagram

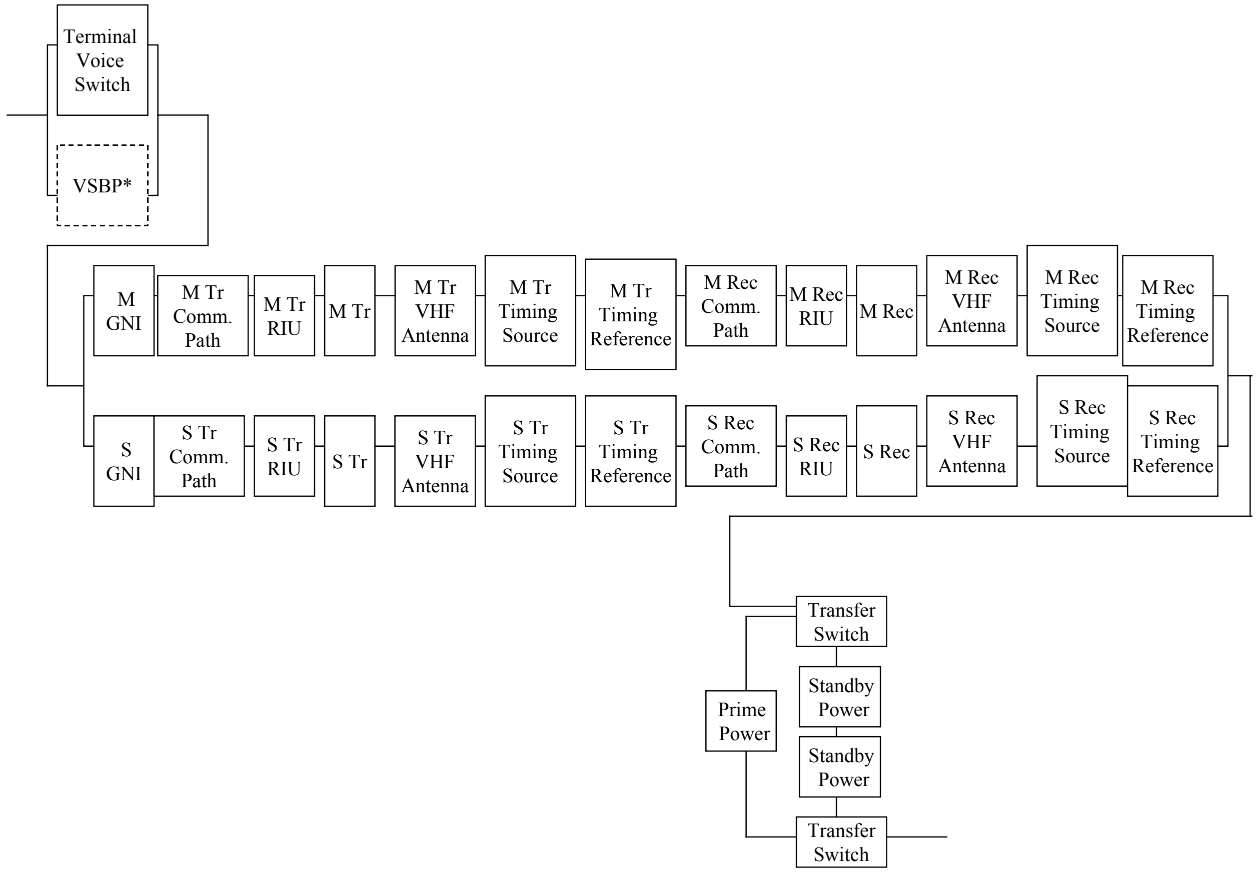
*Many Level 3 ATCT/TRACONs and Above

Figure E-6

NEXCOM Terminal A/G Voice System – Split Main/Standby



(a) Physical Configuration



(b) Reliability Block Diagram

*Many Level 3 ATCT/TRACONs and Above

Figure E-7

NEXCOM Terminal A/G Voice System – Transmitter/Receiver Split: Redundant RIU

Table E-8

Terminal A/G Voice Switch Availabilities Over 3 Years

Switch Type	Year	Number of Switches**	Switch Availability*
ICSS48BA	03/98-02/99	173.417	0.99990
	03/99-02/00	165.667	0.99962
	03/00-02/01	157.167	0.99991
ICSS48BB	03/98-02/99	27.833	0.99993
	03/99-02/00	23.000	0.99993
	03/00-02/01	20.417	0.99749
ICSS48BC	03/98-02/99	68.250	0.99958
	03/99-02/00	63.083	0.99985
	03/00-02/01	62.667	0.99931
TVS48HA	03/98-02/99	146.167	0.99999
	03/99-02/00	150.083	0.99998
	03/00-02/01	151.417	0.99995
TVS48HB	03/98-02/99	4.083	0.99998
	03/99-02/00	6.833	1.00000
	03/00-02/01	28.5	0.99996
TVS48HC	03/98-02/99	58.083	0.99826
	03/99-02/00	70.500	0.99998
	03/00-02/01	80.917	0.99992

* As reported in NASPAS data FY1998, FY1999, FY2000

** Fractional values for numbers of switches because some switches not in place the whole year

An availability analysis was performed for the split M/S configuration shown in Figure E-6, and the STR configuration shown in Figure E-7.

Table E-9 shows that without VSBP, 0.99999 cannot be achieved for Terminal A/G Service availability using either the split M/S or STR configurations.

Table E-10 shows that the split M/S configuration provides a higher availability than the STR configuration. Table E-10 also shows that it may be difficult to achieve a service availability of 0.99999 using the two-sited STR configuration in the Terminal environment. This result is, of course, based upon the assumptions, but nevertheless, it should raise a flag regarding use in the Terminal environment of the two-sited STR configuration.

Table E-9

NEXCOM Terminal Domain Voice Service Availability – No VSBP

GNI MTBF (hrs)	Split M/S*		Split Trans./Rec. (STR)**	
	TVS (0.9999)	TVS (0.99749)	TVS (0.9999)	TVS (0.99749)
10,000	0.999893987	0.997484001	0.999874971	0.997465032
27,000	0.999894140	0.997484154	0.999875274	0.997465333
30,000	0.999894149	0.997484163	0.999875292	0.997465351
40,000	0.999894169	0.997484183	0.999875331	0.997465391
100,000	0.999894205	0.997484219	0.999875403	0.997465462

* Split M/S configuration has an RIU both at main and standby sites
** STR configuration has 2 RIUs at transmitter site and 2 RIUs at receiver site

Table E-10

NEXCOM Terminal Domain Voice Service Availability – With VSBP

GNI MTBF (hrs)	Split M/S*		Split Trans./Rec. (STR)**	
	TVS (0.9999)	TVS (0.99749)	TVS (0.9999)	TVS (0.99749)
10,000	0.999993972	0.999993638	0.999974955	0.999974621
27,000	0.999994126	0.999993792	0.999975257	0.999974924
30,000	0.999994135	0.999993801	0.999975275	0.999974941
40,000	0.999994155	0.999993821	0.999975315	0.999974981
100,000	0.999994191	0.999993857	0.999975387	0.999975053

* Split M/S configuration has an RIU both at main and standby sites
** STR configuration has 2 RIUs at transmitter site and 2 RIUs at receiver site

E-5.0 DATA SYSTEM/SERVICE

For data service, both the En Route and Terminal domains are analyzed. Unlike Terminal A/G voice service, whose components are independent of those at the ARTCC, Terminal data service relies upon components at both the ATCT/TRACON and the ARTCC. In the data service configurations analyzed, the assumption is that there is no RIU redundancy, since as seen in the

A/G voice case above, RIU redundancy has little impact on the overall service availability. The same result can be expected for data service.

Also, unlike A/G voice service where the voice switch is included in the service availability computations, the data service unique equipment, except for the A/G Router and HID/NAS LAN, in the ARTCC, is not included in the data service availability computation. The A/G Router and HID/NAS LAN in the ARTCC are included because they are used for NEXCOM-specific purposes.

Currently, the communications service availability provided by the Controller-Pilot Data Link Communications (CPDLC) service in accordance with National Airspace Performance Reporting System, par. 702c, is specified to be 0.999 or greater on an individual sector basis, in accordance with - NAS-SS-1000, FAA NAS System Specification, Volume I, par. 3.2.1.2.8.1g [5]. In addition, CPDLC unique ground equipment is specified to have an inherent availability of 0.999 or greater. Further requirements are that no single point of failure of the CPDLC unique ground equipment **shall** cause a loss of service outage for more than 10 minutes, per paragraph 3.8.1, subparagraph c, d, & e, NAS SR-1000, FAA NAS System Requirements Document [6].

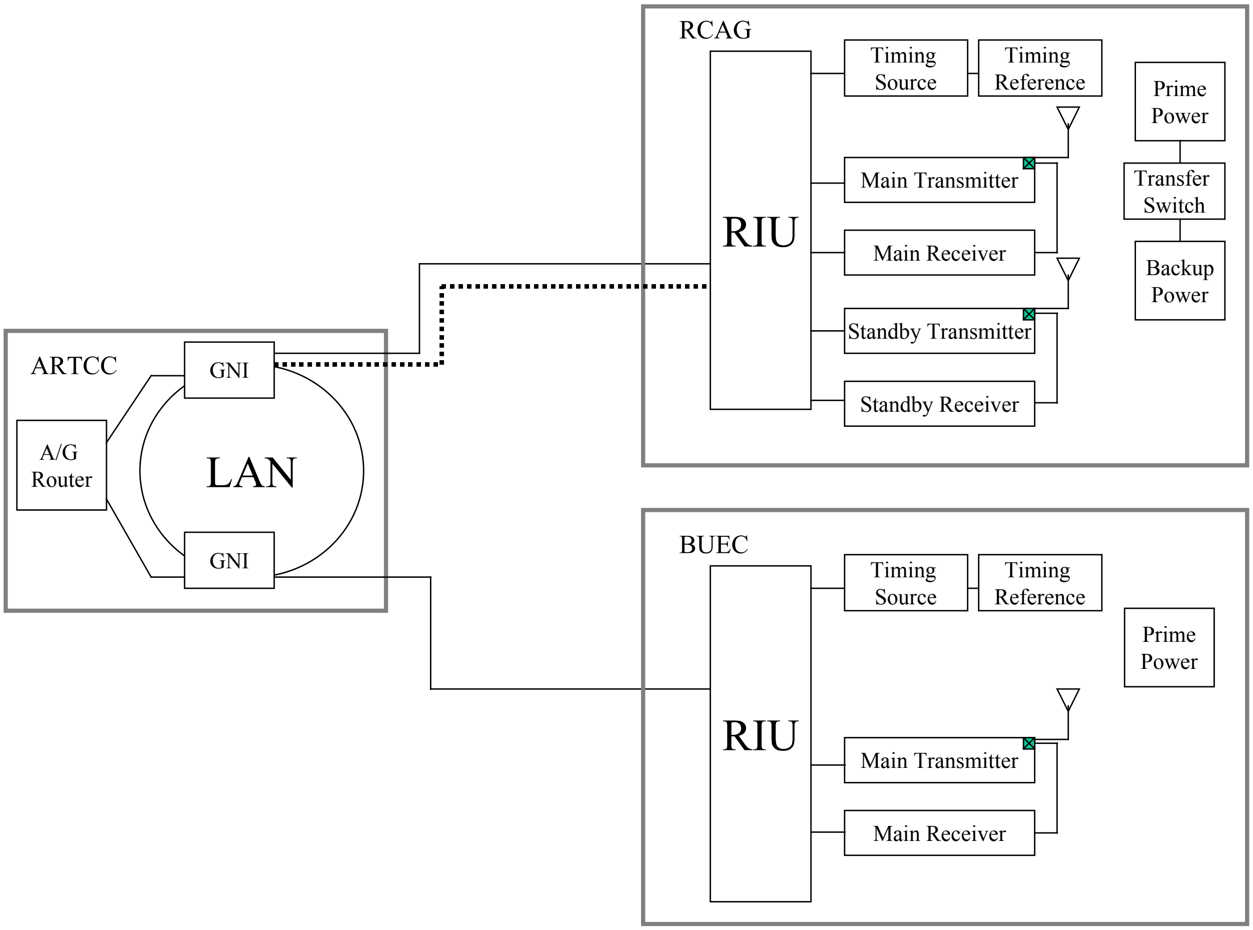
In order for the entire service, which includes the CPDLC unique ground equipment, to meet an availability of 0.99999, the CPDLC unique ground equipment must have an availability exceeding 0.99999. Based on the data system availability results provided in the following sections, the FAA can determine what the availability of the CPDLC unique equipment must be and if redundancy is required in order to meet an overall service availability of 0.99999. This will not be done here.

E.5.1 NEXCOM En Route Data System

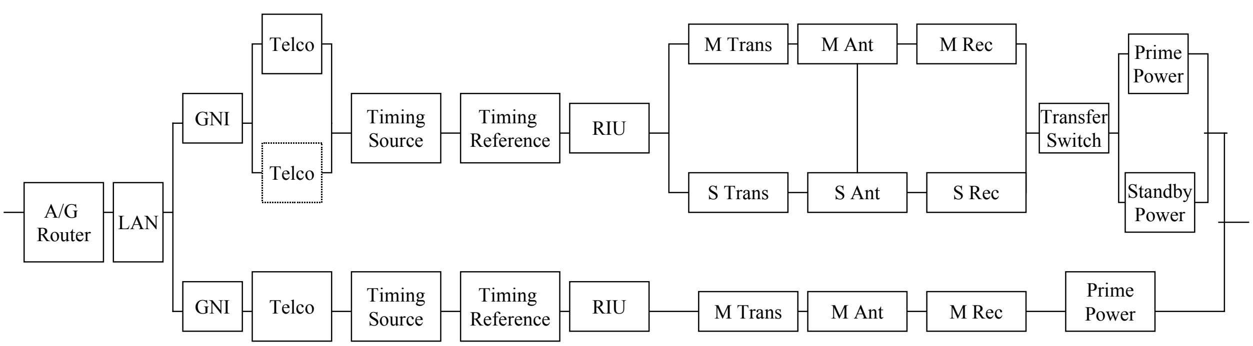
Figures E-8 and E-9 show possible connections for the En Route Data System for En Route Data Service assuming that NEXCOM VDL Mode 3 is being used. In Figure E-8 no redundancy for the A/G Router or the HID/NAS LAN is provided. In Figure E-9 redundancy is provided for the A/G Router. Table E-11a, which assumes a non-redundant LAN, shows the resulting NEXCOM En Route Data Service Availabilities under different assumptions regarding A/G Router redundancy.

Table E-11a shows that the NEXCOM En Route Data Service availability would not meet the 0.99999 availability required of a critical service with redundancy provided for the A/G Router, but not for the LAN. With A/G Router redundancy alone, the data system availability falls between 0.9999 and 0.99999.

However, if the LAN is made redundant in addition to the A/G Router, then Table E-11b shows that an En Route Data Service availability of 0.99999 can be met even with non-redundant telecommunications links.



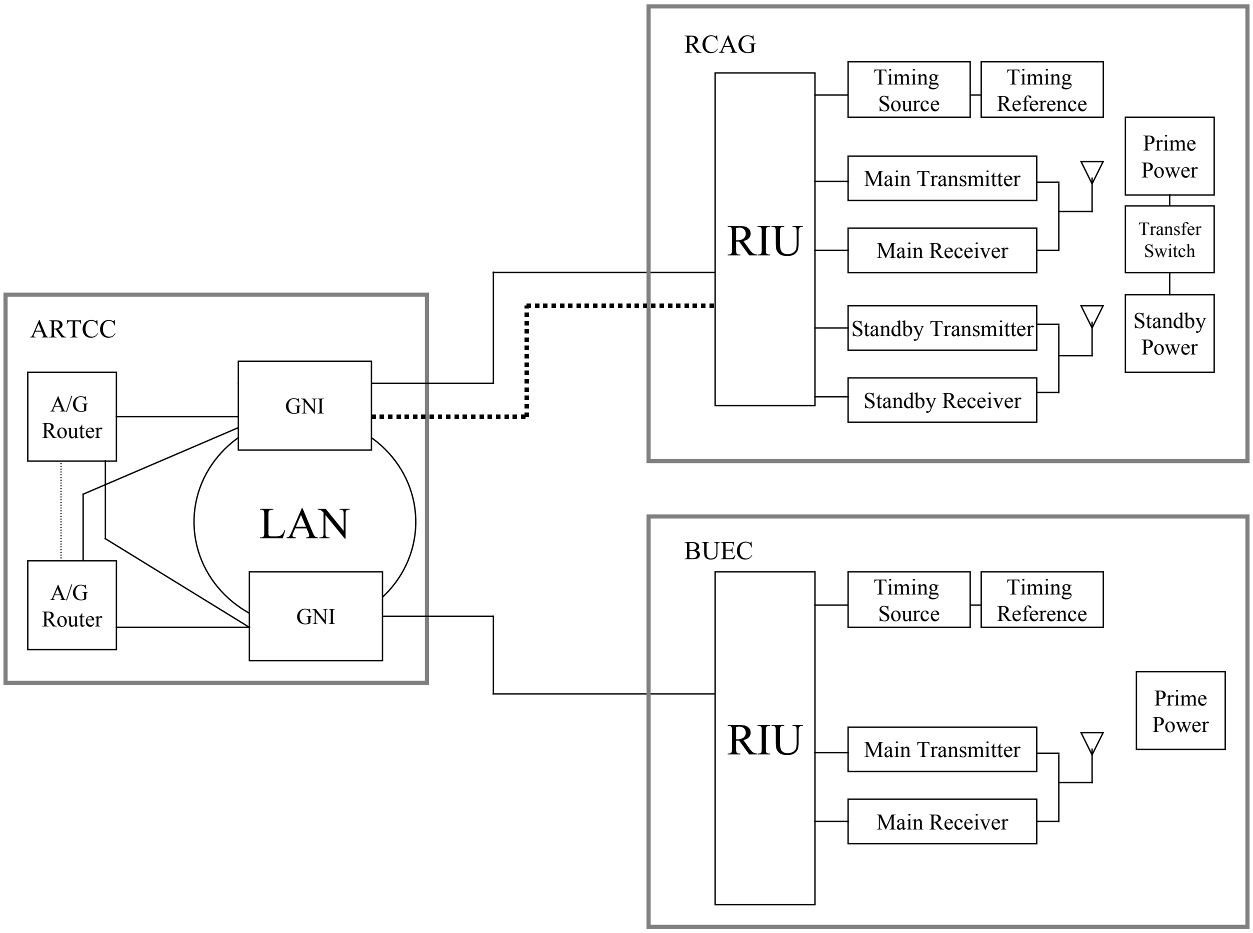
(a) Physical Configuration



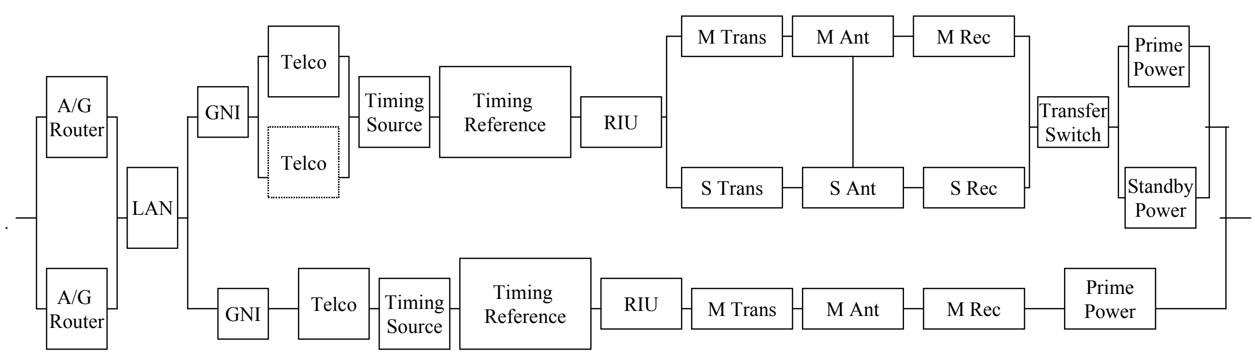
(b) Reliability Block Diagram

Figure E-8

NEXCOM En Route Data System – Non-Redundant A/G Router



(a) Physical Configuration



(b) Reliability Block Diagram

Figure E-9

En Route Data System – Redundant A/G Router

Table E-11a

Data System Availability in En Route Domain (Non-Redundant LAN)

GNI MTBF (hrs)	En Route A/G Data Service Availability* (Non-Redundant LAN)	
	Non-Redundant A/G Router A/B	**Redundant A/G Router A/B**
10,000	0.999874047/0.999888650	0.999974034/0.999988639
27,000	0.999874336/0.999888875	0.999974324/0.999988863
30,000	0.999874353/0.999888888	0.999974340/0.999988877
40,000	0.999874391/0.999888917	0.999974379/0.999988906
100,000	0.999874460/0.999888970	0.999974447/0.999988959

A = Single communications path
B = Redundant communications path
* Computed with non-redundant RIU and RIU MTBF of 40,000 hrs, LAN MTBF of 50,000 hrs

Table E-11b

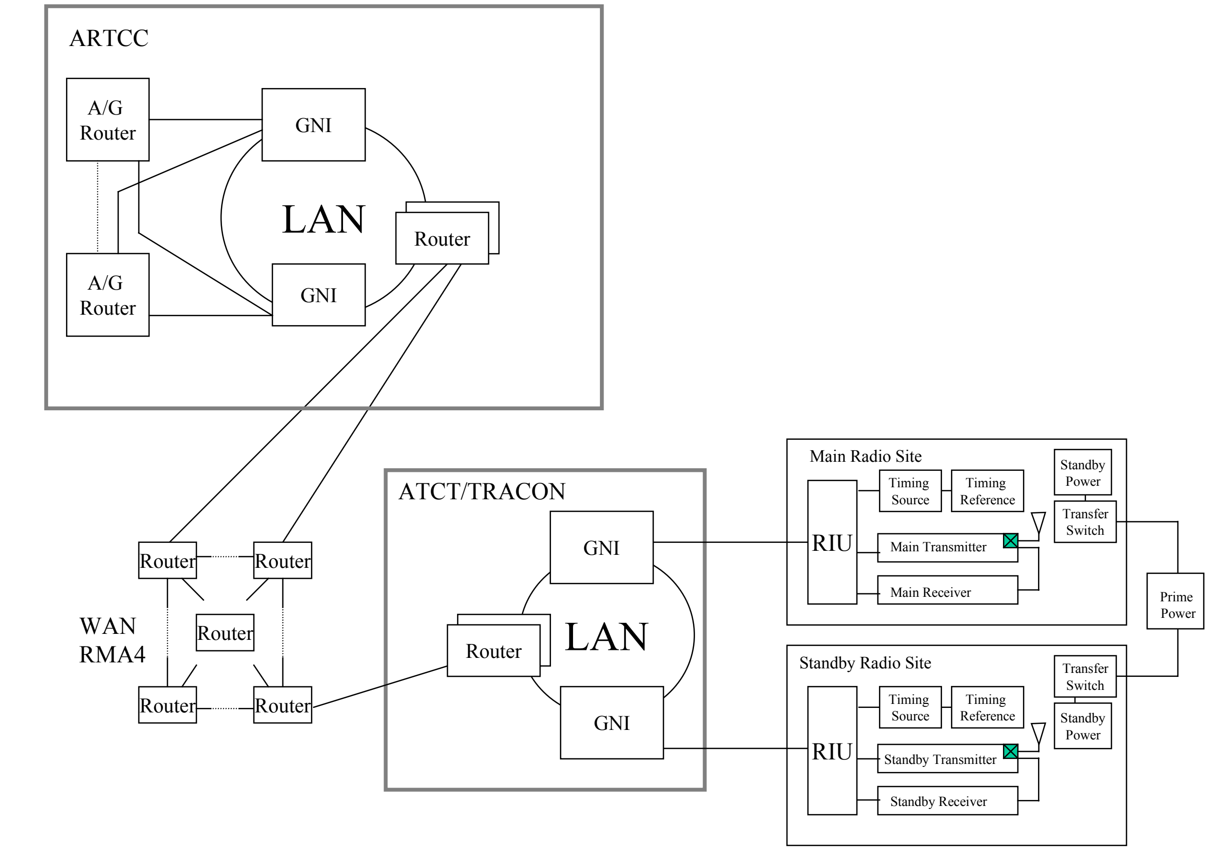
Data System Availability in En Route Domain (Redundant LAN)

GNI MTBF (hrs)	En Route A/G Data Service Availability* (Redundant LAN)	
	Non-Redundant A/G Router A/B	**Redundant A/G Router A/B**
10,000	0.999884045/0.999898649	0.999984032/0.999998639
27,000	0.999884335/0.999898873	0.999984323/0.999998863
30,000	0.999884352/0.999898887	0.999984340/0.999998877
40,000	0.999884390/0.999898916	0.999984378/0.999998906
100,000	0.999884459/0.999898969	0.999984447/0.999998959

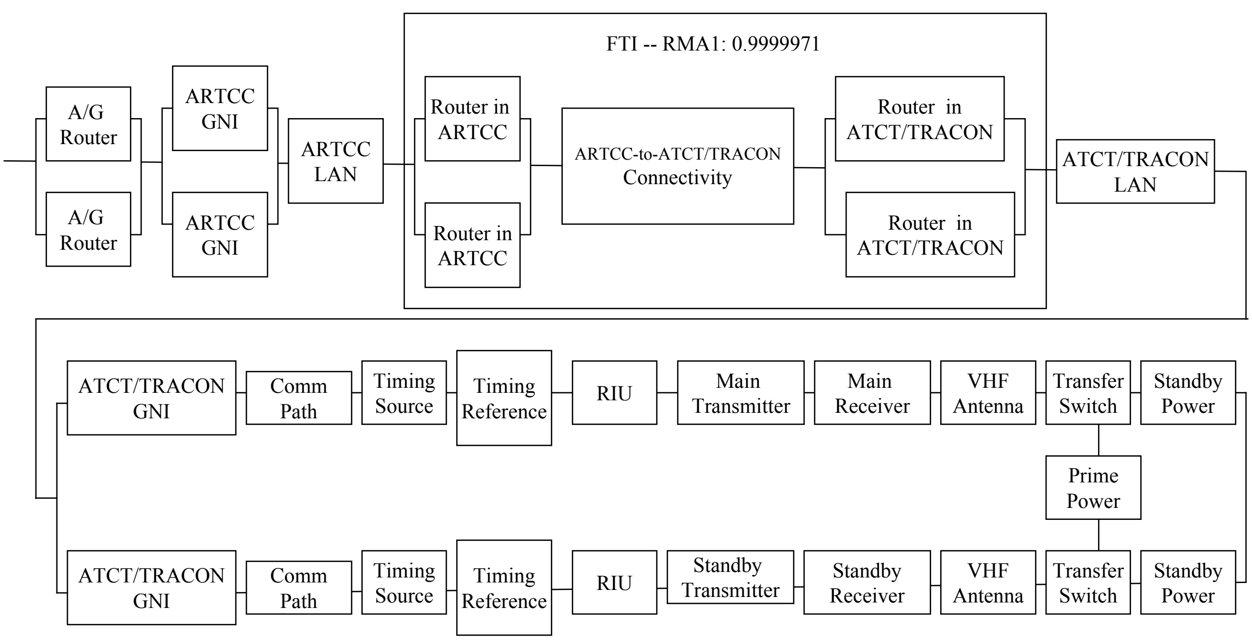
A = Single communications path
B = Redundant communications path
* Computed with non-redundant RIU and RIU MTBF of 40,000 hrs, LAN MTBF of 50,000 hrs

E.5.2 Terminal Data System

Figures E-10 and E-11 show two slightly different configurations for Terminal data service. In Figure E-10, the assumption is that a high availability connectivity through a wide-area network (WAN) is available to interconnect the ATCT/TRACON and the ARTCC. For this case, the predicted FTI availability of 0.9999971 for RMA1 service is used. In Figure E-11, it is assumed that the WAN can provide at most an availability of 0.9979452, which is the predicted



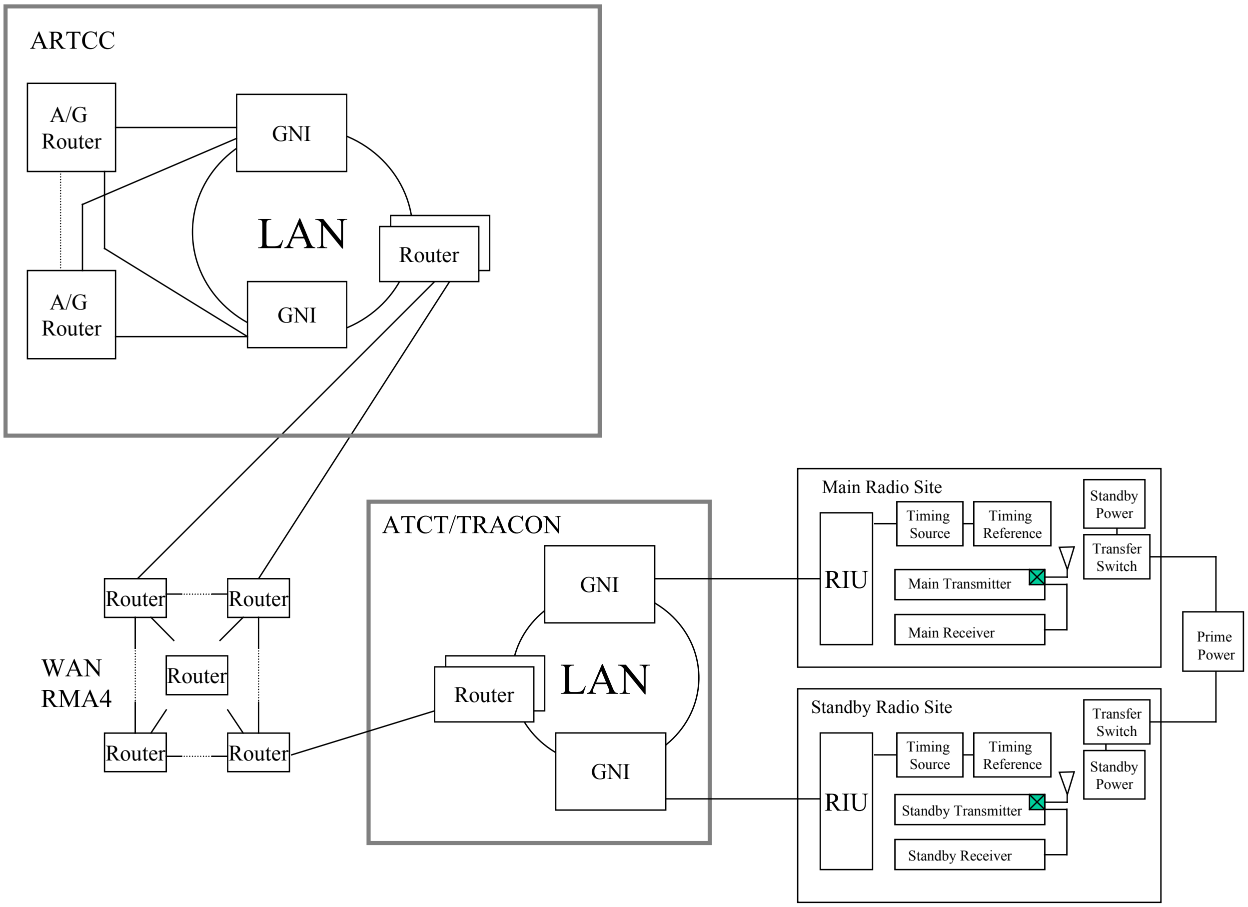
(a) Physical Configuration



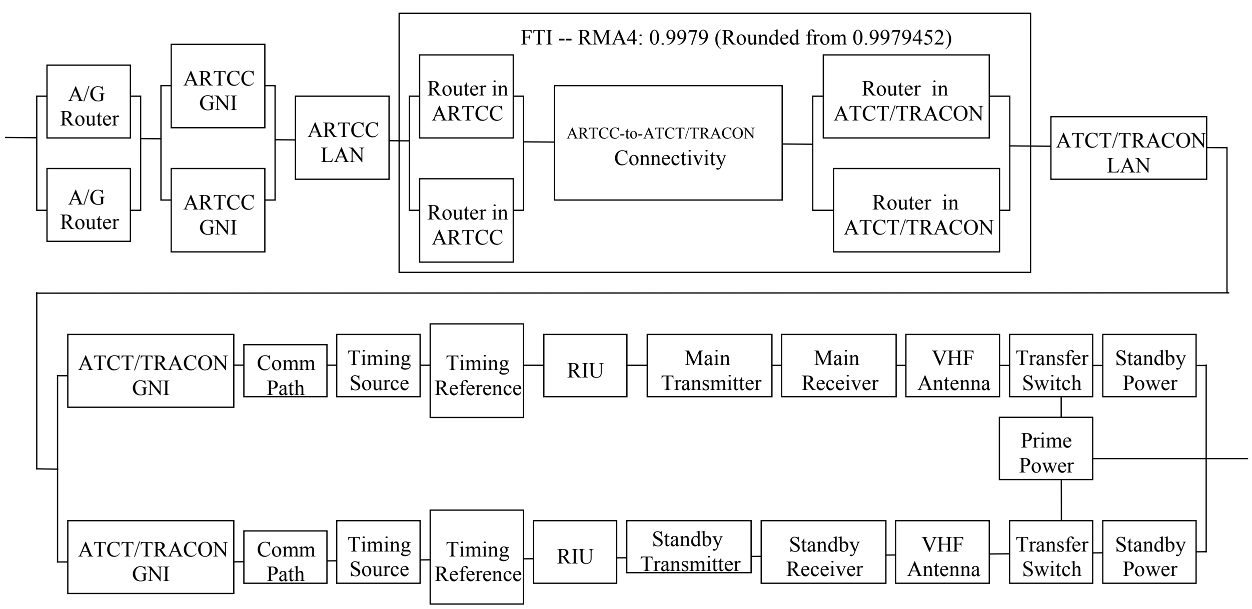
(b) Reliability Block Diagram

Figure E-10

Terminal Domain Data System -- RMA1 WAN Access to ATCT/TRACON



(a) Physical Configuration



(b) Reliability Block Diagram

Figure E-11

Terminal Domain Data System – RMA4 WAN Access to ATCT/TRACON

availability under FTI for RMA4 service. The 0.9999971 and the 0.9979452 should include the availabilities of the ground/ground routers.

In addition, the assumption for Terminal data service is that, in addition to the LAN and GNI in the ATCT/TRACON being operational, the GNI, A/G Router, and LAN at the ARTCC must be operational in order that Terminal data service be operational. Redundancy of the A/G Router in the ARTCC is assumed in the data system availability computation.

Table E-12a shows that even with a high WAN availability (i.e., RMA1), Terminal data service cannot achieve an availability of 0.99999 with a non-redundant LAN. If both LANs (at the ARTCC and ATCT/TRACON) are made redundant, then a 0.99999 availability can be achieved for the A/G Terminal Data System (and hence for A/G Terminal Data Service) as Table E-12b shows.

With an RMA4 WAN availability, then the Terminal data service availability falls below 0.999, regardless of LAN and A/G Router redundancy.

Table E-12a

Data Service Availability in Terminal Domain - Split M/S Configuration Non-Redundant ARTCC and ATCT/TRACON LANs

	Terminal A/G Data Service Availability*	
GNI MTBF (hrs)	**RMA1 WAN**	**RMA4 WAN**
10,000	0.999977309	0.997876038
27,000	0.999973217	0.997876167
30,000	0.999973224	0.997876174
40,000	0.999973241	0.997876191
100,000	0.999973270	0.997876220

* Computed with Redundant A/G Router and RIU MTBF of 40,000 hrs

Table E-12b

Data Service Availability in Terminal Domain - Split M/S Configuration Redundant ARTCC and ATCT/TRACON LANs

	Terminal A/G Data Service Availability*	
GNI MTBF (hrs)	**RMA1 WAN**	**RMA4 WAN**
10,000	0.999993087	0.997895995
27,000	0.999993216	0.997896124
30,000	0.999993224	0.997896132
40,000	0.999993240	0.997896148
100,000	0.999993270	0.997896178

* Computed with Redundant A/G Router and RIU MTBF of 40,000 hrs

E.6.0 GNI MTBF

As the previous results show, it is possible to satisfy the En Route and Terminal service availability requirements with a GNI MTBF of 10,000 hrs, assuming GNI redundancy of the type described earlier in this appendix. (It was not possible to satisfy the service availability requirement only for the two-sited STR configuration in the Terminal environment even for a GNI MTBF of 100,000 hrs) However, the MTBF of the GNI must be balanced against the resulting number of corrective or unscheduled maintenance actions. The curve in Figure E-12 looks into the future where NEXCOM has been extended well into the Terminal environment so that there are a total of 400 facilities NAS-wide. Two GNIs are assumed per facility to account for redundancy of the type discussed earlier. In this case, quite a difference can be seen between the number of corrective maintenance actions required per year with a GNI MTBF of 10,000 hrs -- 700 -- and the number required with a GNI MTBF of 27,000 hrs -- 259. Increasing the GNI MTBF from 10,000 hrs to 27,000 hrs decreases the number of maintenance actions by 441 per year. A further increase in the GNI MTBF from 27,000 hrs to 40,000 hrs decreases the number of maintenance actions by another 84 per year. These differences could be greatly increased if the number of GNIs per facility increases and/or if the number of facilities which contain a GNI increases. Of course, the increased cost for a higher availability GNI must be balanced against the resulting decreased cost corresponding to the reduced number of maintenance actions per year.

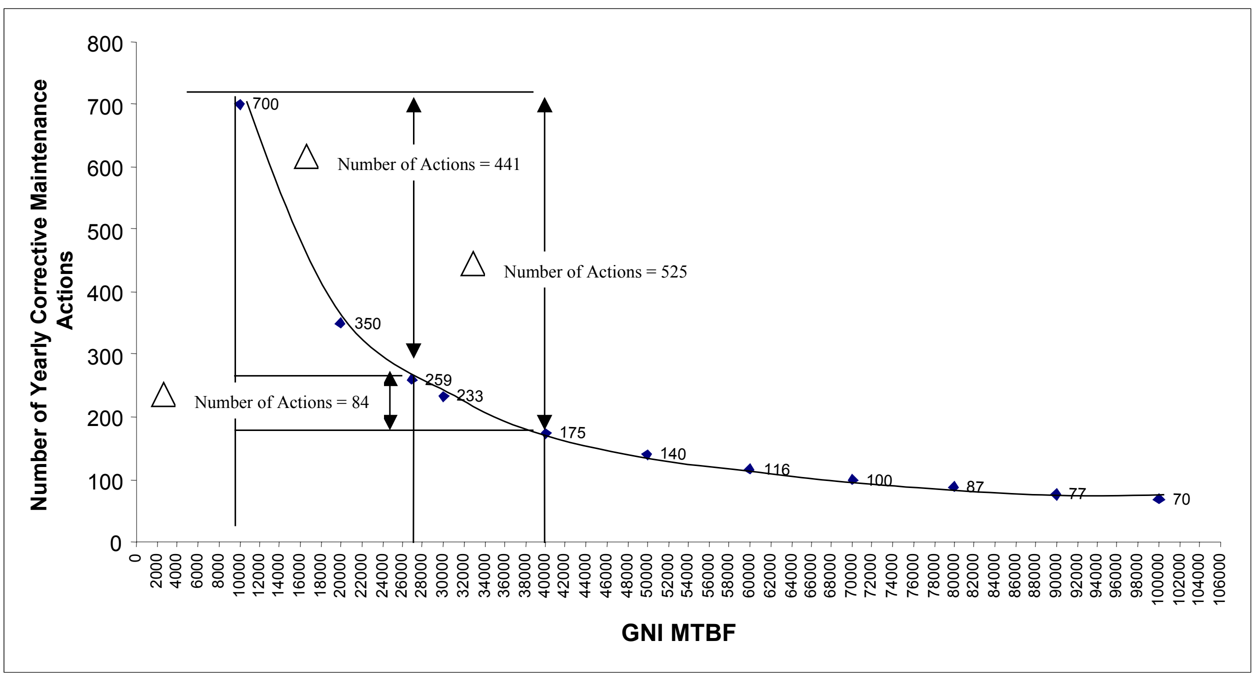


Figure E-12

Corrective Maintenance Actions per Year

E.7.0 CONCLUSIONS

The RD requirements for RCAG MTBO and inherent availability can be met with a T/R MTBF of 26,280 hrs and a non-redundant RIU with an MTBF of at least 27,000 hrs.

BUEC is required in order that en route voice and data services meet the RD availability requirement of 0.99999.

Service availability requirements can also be met in most cases with RIU of 27,000 hrs and GNI MTBF of 10,000 hrs. Redundancy is not required for the RIU, but it is required for the GNI.

Although 27,000 hrs and 10,000 hrs may suffice for the RIU and GNI, respectively, a higher MTBF is recommended to add some margin, and to reduce the number of corrective maintenance actions.

For those cases where BUEC cannot be provided, and there is only coverage from an RCAG, adding a redundant and diverse telecommunications link between the ARTCC and the RCAG can significantly increase the availability of service from the RCAG. Adding redundancy to the RIU minimally increases the service availability regardless of whether or not redundancy is added to the telecommunications link. Because there is no BUEC, a 0.99999 service availability can never be met.

When BUEC is provided, the En Route Service availability requirement of 0.99999 can only be met with GNI redundancy. Redundancy is not required for the RIU in order to meet the service availability requirement. Redundancy is not required for the ARTCC-to-RCAG telecommunications link in order to meet the service availability requirement.

In the Terminal environment, VSBP, which is provided at most level 3 ATCT/TRACONs and above, is required in order to achieve a Terminal A/G Voice Service availability of 0.99999 in the M/S configuration.

It is not possible to achieve a Terminal A/G Voice Service availability of 0.99999 for the two-sited STR configuration, even with VSBP.

In order that the En Route A/G Data Service achieve an availability of 0.99999, redundancy must be added to the A/G Router and the HID/NAS.

With an RMA4 WAN (i.e., 0.9979452), it is not possible for the Terminal A/G Data Service to meet an availability of 0.99999.

With an RMA1 WAN (i.e., 0.9999971) and using the split M/S configuration, in order that the Terminal A/G Data Service achieve an availability of 0.99999, redundancy must be added to the A/G Router, the HID/NAS LAN, and the LAN in the ATCT/TRACON. In order that the En Route A/G Data Service achieve an availability of 0.99999, redundancy must be added to the A/G Router and the HID/NAS LAN.

It is not possible for the Terminal A/G Data Service to achieve an availability of 0.99999 for the two-sited STR configuration even with an RMA1 WAN and redundancy added to the A/G Router and LANs.

Besides system availability considerations, redundancies of the GNI, the A/G Router, and the LANs are required if they are part of a critical service. This follows from FAA Diversity Order 6000.36 [3] which states that there should be no common points of failure for a critical service. But more than this, the GNI and A/G Router are common equipment for multiple critical voice and data connections from A/G radio sites to the voice switch and data service equipment, respectively. Without redundancy, a failure in any of these components could cause the loss of all A/G voice and data service to an ARTCC and/or ATCT TRACON.

While there is considerable latitude with respect to selecting MTBFs for the various components in order to meet a 0.99999 system availability, the implications with regard to the number of corrective maintenance actions should be considered.

E.8.0 REFERENCES

a) Reliability Analysis Center (RAC), Rome Laboratory, Reliability Toolkit: Commercial Practices Edition, p. 404.
b) National Airspace System Performance Analysis System (NASPAS) data for FY98 obtained from AOP-200.
c) FAA Diversity Order 6000.36
d) National Airspace System Performance Analysis system (NASPAS) data for FY98, FY99, FY00 obtained from AOP-200.
e) National Airspace System - System Specifications - 1000 (NAS-SS-1000) document, NAS-SS-1000.
f) National Airspace System, System Requirements - 1000 (NAS-SR-1000) document, NAS-SR-1000.

APPENDIX F

NEXCOM End-to-End Audio Delay Estimates

This appendix discusses the delay allocations for the NEXCOM System architecture to assist in defining
requirements for box-level specifications as well as to help make decisions for transitions.

F.1.0 ARCHITECTURE

The appendix will discuss the end-end architecture with the GNI performing the vocoding function.

F.1.1 GNI Vocoding

The architecture places the vocoders within the Ground Network Interface (GNI) at the control site. This allows the ground telecommunications path to take advantage of the compression of the vocoder to reduce bandwidth requirements. This will also require a vocoder in the RIU to support analog audio for the UHF radios. This architecture assumes the availability of digital transmissions between the control and remote sites via either analog or digital lines. The maximum delays columns incorporate delays and deal with possibilities if associated with the use of analog lines as well as other possible implementation options.

F.2.0 DELAY BUDGETS

Delay budgets reflect field measurements of operational equipment as well as prototype operation. Delay numbers for the Voice Switch and RCE are based on measurements conducted on fielded Voice Switching and Control System (VSCS) and RCE equipment. Delay specifics of the VDL Mode 3 are based on the prototype system.

The Voice Switch equipment and RCE have differing delays for the Push-to-Talk (PTT) signal than for the audio information. As such, this needs to be taken into consideration for a start-up delay, which will be greater than the steady-state audio throughput delay. Using the lower throughput numbers requires the vocoder to be always running and then the PTT signal is used to determine whether the RIU should forward the voice information for transmission. This allows the vocoder to be operating on voice even if the PTT signal has not quite arrived yet. This assumes that the clipping introduced by this difference (which is in today's operational system) is still acceptable and NEXCOM is not forced to buffer out the clipping. If so, then the start-up delay becomes the throughput delay.

The delay budgets are broken out separately for uplink and downlink due to this PTT impact, and the fact that different architectures in the air and ground system can vary the numbers.

F.2.1 Uplink Delays

Table F-1 spells out the uplink delay allocations for the GNI vocoding architecture:

Table F-1

VDL Mode 3 Audio Throughput Delay

	Likely	Min	Max	
Voice switch delay	1.20 ms	1.20 ms	2.00 Ms	(Measured from field - VSCS)
Vocoder Analysis	60.00 ms	60.00 ms	60.00 Ms	(dependent on vocoder frame size)
Processing delay	4.00 ms	2.00 ms	4.00 Ms	
Clock out of vocoder	2.60 ms	1.25 ms	20.00 Ms	(4/8bit Parallel @ 9600Hz / Serial @ 4800Hz)
TDMA Framing delay	84.76 ms	84.76 ms	84.76 ms	(4 frame pipeline + prep for transmission)
Modem Processing delay	5.00 ms	5.00 ms	20.00 ms	
Modem Transfer delay	1.71 ms	0.06 ms	10.00 ms	(56k/T1-1.544M/9.6k)
	158.08 ms	153.07 ms	198.76 ms	GNI Tx
Maximum LINCS delay	14.00 ms	5.00 ms	25.00 ms	(MAX 50 ms spec'd - 18.88 ms max likely)
	173.28 ms	159.27 ms	225.76 ms	Ground System (VSCE + GNI)
Processing delay	4.00 ms	2.00 ms	4.00 ms	
RIU/MDR Line Blockage	2.45 ms	0.00 ms	2.45 ms	No blockage vs. Max size packet just started
Transfer delay	0.86 ms	0.86 ms	2.73 ms	(1 vocoder frames in HDLC packet - Max 6 frames)
	7.30 ms	2.86 ms	9.18 ms	RIU Tx
Processing delay	6.00 ms	3.00 ms	6.00 ms	
	6.00 ms	3.00 ms	6.00 ms	MDR Tx
Ground to Antenna	186.59 ms	165.13 ms	240.94 ms	Assumes Vocoder Always Running
Gnd to Ant. Startup	197.39 ms	175.93 ms	253.94 ms	Start of Audio delayed by PTT signal
Processing delay	6.28 ms	3.00 ms	6.28 ms	
Receive slot overhead	4.38 ms	4.38 ms	5.42 ms	(Vocoder frame tx + squelch offset + Propagation) 4Slot TS1 vs. 3Slot TS1
Clock data into vocoder	2.67 ms	1.25 ms	2.67 ms	28 symbols
Vocoder Synthesis	20.00 ms	20.00 ms	20.00 ms	(dependent on vocoder frame size)

Airborne network delay	4.00 ms	2.00 ms	4.00 ms	
	37.32 ms	30.63 ms	38.37 ms	Aircraft Rx
Total	223.91 ms	195.76 ms	279.31 ms	[GOAL: <=250 ms]
StartUp Delay	234.71 ms	206.56 ms	292.31 ms	(Audio delayed by PTT signal)
VDL Mode 3 PTT Delay				
	Likely	**Min**	**Max**	
Voice switch PTT delay	12.00 ms	12.00 ms	15.00 ms	(VSCS maximum delay allowed)
Clipping Possible	10.80 ms	10.80 ms	13.00 ms	

The case with the vocoder in the GNI easily meets the delay requirements for the minimum and likely cases. The worst-case conditions exceed the 250 ms requirement only slightly.

F.2.2 Downlink Delays

Table F-2 spells out the downlink delay allocations for the GNI vocoding architecture:

Table F-2

VDL Mode 3 Audio Throughput Delay

	Likely	**Min**	**Max**	
Airborne network delay	4.00 ms	2.00 ms	4.00 ms	(estimated)
Vocoder Analysis	60.00 ms	60.00 ms	60.00 ms	(dependent on vocoder frame size)
Clock out of vocoder	2.60 ms	1.25 ms	20.00 ms	(4/8bit Parallel @ 9600Hz / Serial @ 4800Hz)
TDMA Framing delay	84.76 ms	84.76 ms	84.76 ms	Just-in-time processing for Vocoder frames 5&6
Processing delay	4.00 ms	2.00 ms	4.00 ms	
	155.37 ms	150.01 ms	172.76 ms	Aircraft Tx
Receive slot overhead	10.19 ms	5.62 ms	13.14 ms	(Vocoder frame tx + squelch offset. Includes Propagation) 4Slot TS2 vs. 4Slot TS1 vs. 3Slot TS2
Processing delay	6.00 ms	5.30 ms	6.00 ms	
RIU/MDR Line Blockage	2.45 ms	0.00 ms	2.45 ms	No blockage vs. Max size packet just started

Transfer delay	0.86 ms	0.86 ms	2.73 ms	(1 vocoder frames in HDLC packet)
	19.50 ms	11.77 ms	24.32 ms	MDR Rx
Processing delay	6.28 ms	3.00 ms	6.28 ms	
	6.28 ms	3.00 ms	6.28 ms	RIU Rx
Maximum LINCS delay	14.00 ms	5.00 ms	25.00 ms	(MAX 50 ms spec'd - 18.88 ms max likely)
Modem Processing delay	5.00 ms	5.00 ms	20.00 ms	
Modem Transfer delay	1.71 ms	0.06 ms	10.00 ms	(56k/T1-1.544M/9.6k)
Vocoder Synthesis	20.00 ms	20.00 ms	20.00 ms	(dependent on vocoder frame size)
Clock data into vocoder	2.67 ms	1.25 ms	2.67 ms	28 symbols
GNI Processing delay	4.00 ms	2.00 ms	4.00 ms	
	33.38 ms	28.31 ms	56.67 ms	GNI Rx
Voice switch delay	1.20 ms	1.20 ms	2.00 ms	(VSCS maximum delay allowed)
	48.58 ms	34.51 ms	83.67 ms	Ground System
Total	229.72 ms	199.30 ms	287.03 ms	[GOAL: <=250 ms]

F.2.2.1 Vocoding and Modem Delays

With the GNI providing the vocoding function, the minimum and likely cases can easily meet the ICAO end-to-end requirements. The worst-case condition is only slightly worse than the case with the RIU providing the vocoding function. The major difference is the use of modems for analog transmission, which can add significant processing delays to the system. Care must be taken in making sure the modem does not have excessive delays.

F.2.3 Uplink PCM Voice

For comparison purposes, the delay implications of using the proposed RIU/MDR Digital interface (using PCM audio) between the RIU and MDR to handle uplink DSB-AM voice communications are provided in Table F-3:

Table F-3

DSB-AM PCM Audio Throughput Delay

	Likely	Min	Max	
Voice switch delay	1.20 ms	1.20 ms	2.00 ms	(Measured from field - VSCS)
Vocoder Analysis	60.00 ms	60.00 ms	60.00 ms	(dependent on vocoder frame size)
Processing delay	4.00 ms	2.00 ms	4.00 ms	
Clock out of vocoder	2.60 ms	1.25 ms	20.00 ms	(4/8bit Parallel @ 9600Hz / Serial @ 4800Hz)
TDMA Framing delay	84.76 ms	84.76 ms	84.76 ms	(4 frame pipeline + prep for transmission)
Modem Processing delay	5.00 ms	5.00 ms	20.00 ms	
Modem Transfer delay	1.71 ms	0.06 ms	10.00 ms	(56k/T1-1.544M/9.6k)
	158.08 ms	153.07 ms	198.76 ms	GNI Tx
Maximum LINCS delay	14.00 ms	5.00 ms	25.00 ms	(MAX 50 ms spec'd - 18.88 ms max likely)
	173.28 ms	159.27 ms	225.76 ms	Ground System (VSCE + GNI + Telco)
Processing delay	4.00 ms	2.00 ms	4.00 ms	
Clock data into vocoder	2.67 ms	1.25 ms	2.67 ms	28 symbols
Vocoder Synthesis	20.00 ms	20.00 ms	20.00 ms	(dependent on vocoder frame size)
RIU/MDR Line Blockage	10.48 ms	0.00 ms	10.48 ms	No blockage vs. Max size packet just started
Transfer delay	10.48 ms	10.48 ms	10.48 ms	(PCM voice frame in HDLC packet)
	47.63 ms	33.73 ms	47.63 ms	RIU Tx
Clock drift	0.90 ms	0.90 ms	1.80 ms	
Processing delay	6.28 ms	3.00 ms	7.20 ms	
	7.18 ms	3.90 ms	9.00 ms	MDR Tx
Ground to Antenna	228.09 ms	196.90 ms	282.39 ms	Assumes Vocoder Always Running
Gnd to Ant. Startup	238.89 ms	207.70 ms	295.39 ms	Start of Audio delayed by PTT signal
Processing delay	6.28 ms	3.00 ms	6.28 ms	
Clock into D/A	0.13 ms	0.13 ms	0.13 ms	8000Hz

Airborne network delay	4.00 ms	2.00 ms	4.00 ms	
	10.41 ms	5.13 ms	10.41 ms	Aircraft Rx
Total	238.49 ms	202.03 ms	292.79 ms	[GOAL: <=250 ms]
StartUp Delay	249.29 ms	212.83 ms	305.79 ms	(Audio delayed by PTT signal)
		PCM PTT Delay		
	Likely	**Min**	**Max**	
Voice switch PTT delay	12.00 ms	12.00 ms	15.00 ms	(VSCS maximum delay allowed)
Clipping Possible	10.80 ms	10.80 ms	13.00 ms	

F.2.4 Downlink PCM Voice

Table F-4 spells out the downlink delay allocations for the RIU/MDR Digital interface (using PCM audio)operation:

Table F-4

DSB-AM PCM Audio Throughput Delay

	Likely	**Min**	**Max**	
Airborne network delay	4.00 ms	2.00 ms	4.00 ms	(COMPLETE GUESS)
Processing delay	6.28 ms	3.00 ms	6.28 ms	
	10.28 ms	5.00 ms	10.28 ms	Aircraft Tx
AGC Attack Time	10.00 ms	10.00 ms	10.00 ms	Per MDR SSS
Clock out of A/D	0.13 ms	0.13 ms	0.13 ms	8000Hz
PCM Frame Buffering	20.00 ms	15.00 ms	25.00 ms	To prevent underflow
Clock drift	0.90 ms	0.00 ms	1.80 ms	
Processing delay	6.28 ms	3.00 ms	6.28 ms	
RIU/MDR Line Blockage	0.00 ms	0.00 ms	0.00 ms	Frame Buffering provides enough warning to clear line
Transfer delay	10.48 ms	7.94 ms	12.94 ms	(PCM voice frame in HDLC packet)
	47.79 ms	36.06 ms	56.14 ms	MDR Rx

Processing delay	4.00 ms	2.00 ms	4.00 ms	
Buffer Padding	8.00 ms	8.00 ms	8.00 ms	Padding for processing & clock drift variations of MDR
Vocoder Analysis	60.00 ms	60.00 ms	60.00 ms	(dependent on vocoder frame size)
Clock out of vocoder	2.60 ms	1.25 ms	2.60 ms	(4/8bit Parallel @ 9600Hz / Serial @ 4800Hz)
Clock drift	0.90 ms	0.00 ms	1.80 ms	
Modem Processing delay	5.00 ms	5.00 ms	20.00 ms	
Modem Transfer delay	1.71 ms	0.06 ms	10.00 ms	(56k/T1-1.544M/9.6k)
	82.22 ms	76.31 ms	106.40 ms	RIU Rx
Maximum LINCS delay	14.00 ms	5.00 ms	25.00 ms	(MAX 50 ms spec'd - 18.88 ms max likely)
Buffer Padding	10.00 ms	9.00 ms	34.00 ms	Padding for processing variations of RIU
Vocoder Synthesis	20.00 ms	20.00 ms	20.00 ms	(dependent on vocoder frame size)
Clock data into vocoder	2.67 ms	1.25 ms	2.67 ms	28 symbols
GNI Processing delay	4.00 ms	2.00 ms	4.00 ms	
	36.67 ms	32.25 ms	60.67 ms	GNI Rx
Voice switch delay	1.20 ms	1.20 ms	2.00 ms	(VSCS maximum delay allowed)
	51.87 ms	38.45 ms	87.67 ms	Ground System
Total	192.15 ms	155.82 ms	260.49 ms	[GOAL: <=250 ms]

F.3.0 EXAMPLE IMPLEMENTATION DELAY BUDGET

F.3.1 RESERVED

F.3.2 VDL Mode 3 Maximum Audio Processing Delays (local RIU vocoding)

F.3.2.1 Uplink VDL Mode 3 Delay in GNI

Uplink VDL Mode 3 Delay in GNI with timing as illustrated in Figure F-1 is itemized below:

60ms	vocoder encoding delay
94ms	maximum 5 vocoder frame (100ms) silence padding. ***Note**: Fr 1 of silence pattern is modulated 6ms earlier than end of voc fr 6 T1 transmission ends if worst case timing in RIU & on T1 line.*
6ms	GNI Processing Time
1.5ms	GNI max. vocoder timing uncertainty
4.6ms	Send 6th vocoder frame's voice burst message over T1 (27 bytes) single vocoder frame (assumes a single DS0 for GNI/RIU).
Toff	Timing offset (T1 path delay) from GNI to RIU

Total = Toff + 166.1ms

***Note**: No T-1 line blocking should occur when sending vocoder frame 6 since the GNI will be aware of the PTT since before sending frames 1-5. Although some GNI/RIU T1 line blocking may occur when sending vocoder frames 1-5 to the RIU, it does not contribute to the audio delay. Vocoder frames 1-5 only need to arrive at the MDR 8.5ms prior to ramp-up/start of frame modulation. See Figure F-3 for example of message transmission timing for frames 1-6.*

F.3.2.2 Downlink VDL Mode 3 Delay in GNI

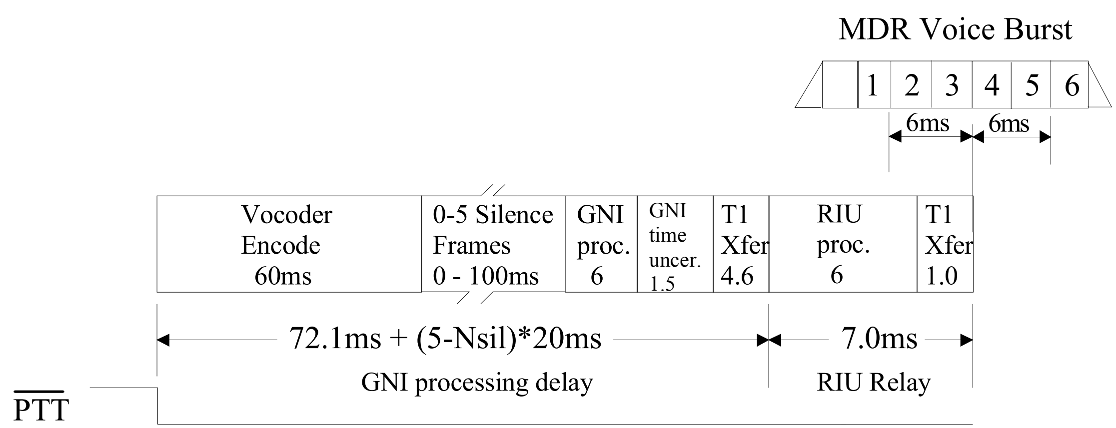
The following delays are relative to the TOA in the 1st voice burst message of a reception from the MDR receiver (vocoder frame 1 sent by itself):

5.28ms	(55.5 symbols from TOA to end of vocoder frame 1)
8.00ms	MDR max. processing time
4.0ms	T1 transfer of frame 1 + blockage from MDR to RIU
Toff1	One way Timing offset on MDR/RIU link (T1 path delay)
16.5ms	T1 DS0 line blockage, T1 DS0 transfer (1 frame), RIU to GNI ***Note**: 6ms RIU processing is concurrent with this 16.5ms interval*
1.5ms	GNI epoch timing uncertainty
Toff2	One way Timing offset on RIU/GNI link (T1 path delay)
6.00ms	GNI max. processing time
20.0ms	Vocoder decode time

Total: Toff1 + Toff2 + 61.28ms

Notes:

1. *The RIU must pass along the TOA field from the MDR to the GNI.*
2. *This is also the "minimum" allowed delay in the GNI to avoid voice underflow. i.e., a GNI should adjust its delay to the above value. If the specific MDR/RIU/GNI maximum processing times are known to the GNI and they are less than the absolute maximums shown above, the GNI may reduce the delay appropriately.*



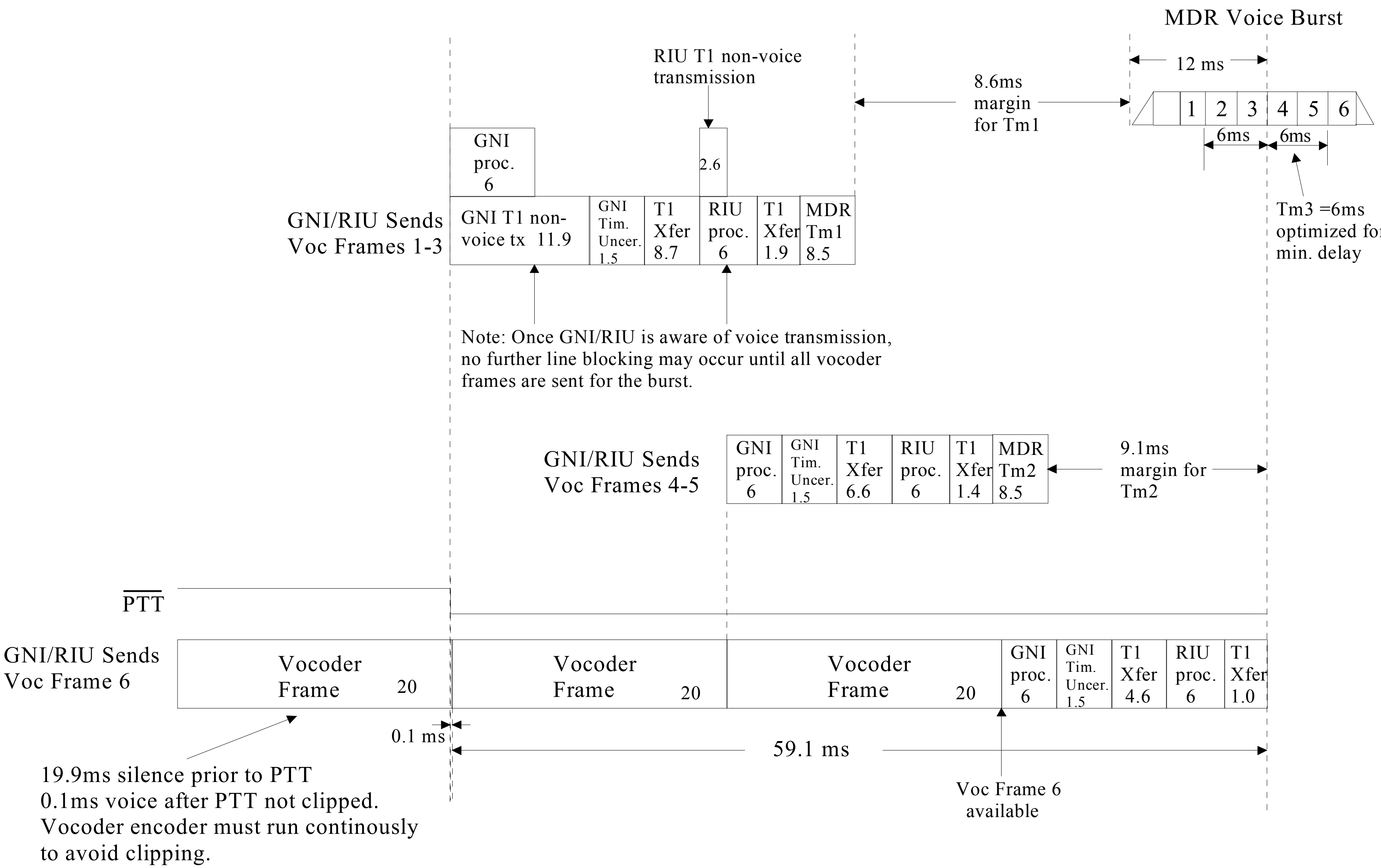
Nsil = no. silence frames inserted at GNI (0-5)

Uplink audio delay (not including airborne decode time) = 72.1ms + (5-Nsil)*20ms + Nsil*20ms + 7.0 (RIU) - 6ms = 173.1 ms

Assumes GNI/RIU Telco link uses a single DS0 (56kbps) with same HDLC message format as RIU/MDR

Figure F-1

GNI-RIU-MDR Uplink VDL Mode 3 Vocoder Timing



Uplink audio delay (not including airborne decode time) = 59.2ms + 100 (5 silence fr) + 19.9ms(voc fr silence) - 6ms (MDR fr 1 mod time) = 173.1 ms
Note: The uplink delay is the same (171.7) regardless of where PTT occurs within Vocoder frame

Assumes GNI/RIU Telco link uses a single DS0 (56kbps) with same HDLC message format as RIU/MDR

Figure F-2
GNI-RIU-MDR Uplink Vocoder Timing, frames 1-6

F.4.0 CONCLUSIONS

The GNI vocoding architecture will likely only require waivers where there are long delays in the ground telecommunications segment. Furthermore, the PCM Voice interface between the RIU and MDR is not foreseen to cause any significant delay implications to the operation of the DSB-AM system.

APPENDIX G

Excess Timing Error for VDL Mode 3 Ground Stations

This appendix discusses what happens to VDL Mode 3 performance when the timing difference between two "bundled" VDL Mode 3 ground stations (sharing two slots on a single frequency) exceeds the one symbol period allocated in the timing budget. This issue has a bearing on the amount of time that a ground station's timing can coast if it loses connectivity to an absolute time source.

Under normal operating conditions, the time budget is based on a desire to keep the important parts of the waveforms from overlapping. The worst case arises when a V/D message coming from a distant aircraft radio impinges on a beacon from a nearby ground station using the next slot. The situation is depicted in the figure on the next page. The figure shows that the guard time between slots is one symbol period longer than the guard time within a slot. This extra symbol period is what is allocated for the time difference between slots. The total of 29 symbol periods is allocated as follows:

> 26 symbol period allowance for a 401 nmi round trip propagation delay, i.e., 200.5 nmi each way
>
> 1 symbol period allowance for aircraft transmitter timing error with respect to its ground station
>
> 1 symbol period allowance for aircraft receiver timing error with respect to its ground station
>
> 1 symbol period allowance for timing differences between ground stations

When the allowances conspire to add up in the worst possible way, the situation is as depicted in the middle part of the figure. The ramp times are allowed to overlap, but the end of the V/D message and the power stabilization plateau are protected.

If the time error between the ground stations exceeds the allowance by 3 extra symbol periods, the worst-case situation looks like the bottom part of the figure. In this case there are two possible negative effects. The end of V/D message interferes with the power stabilization plateau and vice versa. These are discussed separately.

The disruption to the power stabilization process is minimal because the power of the interfering signal is never bigger than that of the desired signal. Actually, in the worst possible case, the power of the interferer is 6 dB less. Since the power stabilization plateau is designed to assist the receiver AGC and since the AGC does not have to be extremely accurate, the interference should be tolerable. At the tail end of the V/D message, where the synchronization sequence begins, the interfering signal is specified to be reduced by another 20 dB, so the SNR of the remainder of the beacon message is at least 26 dB. That level is easily tolerable.

The interference from the beacon to the tail end of the V/D message is a different story. The last three symbols could definitely experience errors at a significant level. If the message is a data message, the interference might easily cause one, or possibly two, Reed Solomon symbol errors. The RS (72, 62) code can correct up to 5 such errors, so the resulting errors should be correctable; however, the tolerance to other error mechanisms will be reduced. If the message is a voice message, then a very strong interferer will cause (on the average) 4.5 bit errors per message. Dividing this number by the 576 bits contained in the message gives a BER of 0.78%. This seems relatively small since the robust vocoder can work in an environment with a BER of several percent. However, all the errors will be concentrated in one vocoder block of 96 bits. As far as that block is concerned, the error rate seems like 6 x 0.78% = 4.7%. Experience has shown that the vocoder can operate in BER environments as high as 5%, so the level of interference should be tolerable. It should once again be borne in mind that tolerance to other interference sources is reduced.

The bottom line is that it appears that the system may be able to tolerate a total timing mismatch between bundled ground stations of up to 4 symbol periods, provided reduced performance versus other forms of interference can be tolerated. Note that the victim signal is presumed to be coming from 200 nmi and is very likely to be experiencing such interference. Nevertheless, if the 4 symbols periods of timing error is evenly divided between the two ground stations, then the error allowed for each one is 190 μs.

Finally, it should be remembered that nonnegligible interference happens only if four different errors are all near their maximum values with the worst possible signs. It cannot happen at all for the preponderance of sectors of sizes (which are mostly less than 160 nmi). The figure below shows the number of V/D symbols that are overlapped as a function of the range of the victim signal emitter from its ground station.

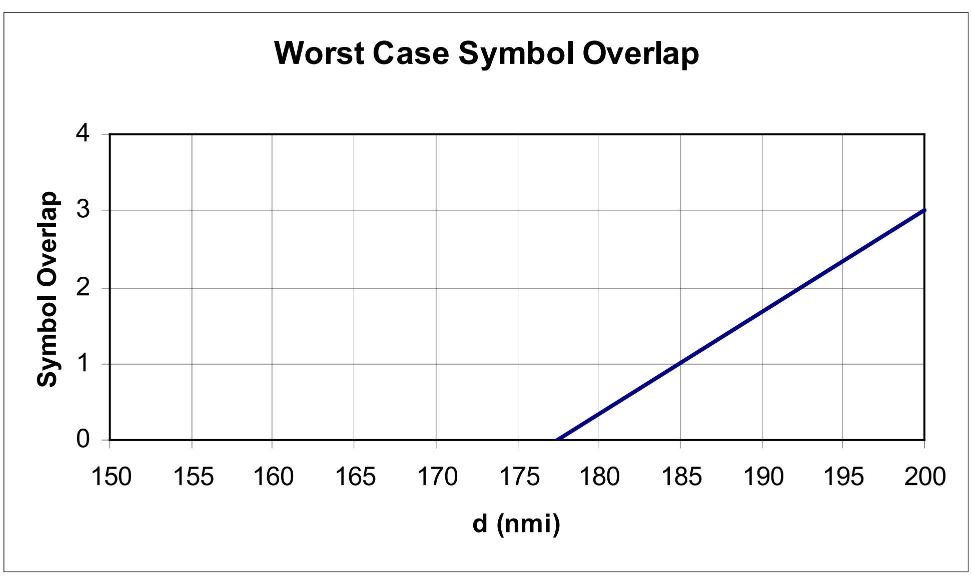


Figure G-1

Worst Case Symbol Overlap

Figure G-1 indicates that if the maximum range is less than or equal to 177 nmi, even the worst case timing considered in this note would not create any overlap. A maximum range of 185 nmi would result in an overlap of only one symbol in the worst case. A one-symbol overlap should cause a minimal degradation in system performance. A similar analysis can be preformed for the 3 slot configurations of VDL Mode 3 but having greater range capability from a timing prospective.

APPENDIX H

Abbreviations and Acronyms

A/G	Air/Ground
ACARS	Aircraft Communications Addressing and Reporting System
ACF	Area Control Facility
ADL	Aeronautical Data Link
AF	Airway Facilities
AFSS	Automated Flight Service Station
AM(R)S	Aeronautical Mobile (Route) Services
ANICS	Alaskan NAS Interfacility Communications System
ARIG	Acquisition Reform Interim Guidance
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASP	Acquisition Strategy Paper
AT	Air Traffic
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
ATN	Aeronautical Telecommunication Network
ATQ	Office of Independent Test and Evaluation
ATR	Antenna Transfer Relay
ATS	Air Traffic Services
BIT	Built-In Test
BUEC	Backup Emergency Communications
CERAP	Combined Center Radar Approach Control
CFR	Code of Federal Regulations
CLNP	Connection-Less Network Protocol
COI	Critical Operational Issue
CPDLC	Controller Pilot Data Link Communications
C-RCE	Control-Radio Control Equipment
D-ATIS	Digital Air Traffic Information Service
DC	Direct Current
DDC	Direct Digital Connectivity
DF	Direction Finder
DLS	Data Link Service or Data Link Sub layer
DSB-AM	Double Sideband Amplitude Modulation
DSR	Display System Replacement
DSRCE	Down Scoped Radio Control Equipment
ECOM	En Route Communications

EEM	Electronic Equipment Modification
EMI	Electromagnetic Interference
ETVS	Enhanced Terminal Voice Switch
EUL-A	End User Location - Type A
EUL-B	End User Location - Type B
FAA	Federal Aviation Administration
FAATSAT	FAA Telecommunications Satellite
FAT	Factory Acceptance Test
FEC	Forward Error Correction
FIFO	First In First Out
FIS	Flight Information Services
FPAM	Front Panel Accessible MMC
FPGA	Field Programmable Gate Array
FSS	Flight Service Station
FTI	FAA Telecommunications Infrastructure
G/G	Ground to/from Ground
GNI	Ground Network Interface
GNIp	Primary GNI
GNIs	Secondary GNI
GPS	Global Positioning System
Hr	Hour
HDLC	High-Level Data Link Control
HID	Host Interface Device
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ICSS	Integrated Communication Switching System
ID	Identification
IDRP	Inter Domain Routing Protocol
ILS	Instrument Landing System
IRD	Interface Requirements Document
ISS	Information System Security
ITU	International Telecommunications Unit
JRC	Joint Resources Council
kbps	kilobits per second
kHz	kilohertz
LAN	Local Area Network
LBAC	Logical Burst Access Channel
LDRCL	Low Density Radio Control Link
LME	Link Management Entity
LMMC	Local Maintenance, Monitoring, and Control

LPA	Linear Power Amplifier
LRU	Lowest Replaceable Unit
M	Main
M/S	Main/Standby
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
MDR	Multimode Digital Radio
MDT	Maintenance Data Terminal
MHz	Megahertz
MMC	Maintenance, Monitoring, and Control
MMCWS	Maintenance Monitoring and Control Work Station
MNS	Mission Need Statement
MOPS	Minimum Operational Performance Standards
MTBF	Mean Time Between Failures
MTTR	Mean Time to Restore
NA	Not Applicable
NAILS	National Airspace Integrated Logistics Support
NAS	National Airspace System
NASPAS	National Airspace System Performance Analysis System
NDI	Non-Developmental Item
NEXCOM	Next Generation Air/Ground Communications
NIMS	NAS Infrastructure Management System
NOTAM	Notice to Airmen
OT&E	Operational Test and Evaluation
PCB	Polychlorinated Bi-Phenol
PCM	Pulse Code Modulation
PDC	Pre-departure Clearance
PKI	Public Key Infrastructure
POST	Power On Self Test
PT	Product Team
PTT	Push-to-Talk
RAPCON	Radar Approach Control
RATCF	Radar Air Traffic Control Facility
RCAG	Remote Center Air/Ground Facility
RCE	Radio Control Equipment
RCF	Remote Communications Facility
RCL	Radio Communications Link
RCO	Remote Communications Outlet
RD	Requirements Document
RDVS	Rapid Deployment Voice Switch
RF	Radio Frequency

RFI	Radio Frequency Interference
RIU	Radio Interface Unit
RMA	Reliability, Maintainability, and Availability
RMM	Remote Maintenance Monitoring
RMMC	Remote Maintenance Monitoring and Control
RMMS	Remote Maintenance Monitoring System
R-RCE	Remote - Radio Control Equipment
RTCA	RTCA, Inc. (formerly Radio Technical Commission for Aeronautics)
RTR	Remote Transmitter/Receiver
RU	Rack Unit
Rx	Receive
S	Standby
SARPs	Standards and Recommended Practices
SRD	System Requirements Document
SSS	Subsystem Specification
STARS	Standard Terminal Automated Replacement System
STR	Separated Transmitter/Receiver
STVS	Small Tower Voice Switch
T/R	Transmitter/Receiver
T&E	Test & Evaluation
TDLS	Tower Data Link Service
TDMA	Time Division Multiple Access
TE	Throughput Efficiency
TOA	Time Of Arrival
TOC	Transfer of Communication
TRACON	Terminal Radar Approach Control
TSGR	Transport Systems Generic Requirements
Tx	Transmit
Tx/Rx	Transmit/Receive or Transmitter/Receiver
UHF	Ultra High Frequency
USAF	United States Air Force
V	Volts
V + U	VHF + UHF
V/D	Voice/Data
VDL	VHF Digital Link
VEARS	VSCS Emergency Access Radio System
V/U/M/S	VHF/UHF/MAIN/STANDBY
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VORTAC	VHF Omni directional Range/Tactical Air Navigation
VSBP	Voice Switch Bypass

VSCE	Voice Switching and Control Equipment
VSCS	Voice Switching and Control System
VTABS	VSCS Training and Backup System
XID	Exchange Identifier (frame)
XPLP	X.25 Packet Layer Protocol